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FRUIT AND VEGETABLE
PROCESSING AND TECHNOLOGY DIVISION
of the
DEPARTMENT OF HORTICULTURE
OHIO AGRICULTURAL EXPERIMENT STATION
THE OHIO STATE UNIVERSITY
in cooperation with
THE OHIO AGRICULTURAL EXTENSION SERVICE

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Columbus 10, Ohio

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TOMATO VARIETY EVALUATION FOR PROCESSING - 1961

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The 1961 tomato variety trials included twelve varieties which grew in replicated plots under accep table commercial practices at Columbus, Ohio. Each variety was harvested at regular intervals.

Quality was determined as follows (the results as reported in the following tables are the average values):

Size or Average Count per 25 Pounds - The total number of tomatoes per 25 pounds.

Raw Grade - The U. S. Grade was determined in accordance with the U. S. Standards for Tomatoes for Canning. The number 2's were separated into those that were 2's for COLOR and those that were 2's for DEFECTS. All grading was done using the Macbeth (Examolite) daylight type lamp with no other light (artificial or natural) interfering.

Agtron F - The Agtron "F" values were determined using 70 as a standard. Samples were taken at the extractor and from the finished canned juice after approximately three (3) months' storage.

Total Acid - Determined by direct titration and calculated as percent citric acid.

pH - Determined with the Beckman Zeromatic pH meter.

Vitamin C or Ascorbic Acid - Determined by Dye titration and calculated as milligrams per 100 grams.

Percent Soluble Solids - Determined from the refractive indice using the Abbe '56 refractometer.

U. S. Grade for Canned Tomatoes - The U. S. Grade was determined in accordance with the U. S. Standards for Grades of Canned Tomatoes.

U. S. Grade for Tomato Juice - The U. S. Grade for Tomato Juice was determined in accordance with the U. S. Standards for Grades of Canned Tomato Juice.

Viscosity - Determined by using an efflux tube (GOSUC) - Consistometer using a 5/64 inch opening and standardized at 23 seconds at 25° C. with water.

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Table I - Tomato Variety Evaluation - Summary Raw Product Data - Columbus 1961

VARIETY	AVERAGE COUNT PER 25#	PERCENTAGE YIELD BY HARVEST 8/30	9/6	9/12	9/21	T/Acre	%No.1	%No.2C	%No.2D	% Culls
Rutgers	83.3	19.3	27.5	27.5	25.7	17.21	55.6	18.7	24.9	0.8
Heinz 1370	105.8	6.2	34.6	45.9	13.3	25.52	61.3	29.6	8.6	0.5
KC 146	82.7	15.5	41.2	19.6	23.7	24.31	68.3	18.3	12.8	0.6
Fireball	110.9	73.7	26.3	-	-	6.43	64.7	7.9	23.9	3.3
C - 52	138.6	33.4	22.2	16.4	28.0	19.33	69.2	17.5	11.9	1.4
ES 24	95.05	16.8	34.0	30.7	18.5	26.94	67.95	20.05	11.35	0.55
Tecumseh	123.85	35.0	36.2	16.3	12.5	14.33	64.5	19.55	15.35	0.6
Hoytville No. 6	82.2	34.4	36.0	19.1	10.5	15.89	57.4	20.7	21.5	0.4
Hotset	131.12	40.1	22.9	22.9	14.1	13.68	57.9	20.4	20.7	1.0
Heinz 1409	92.1	20.3	47.8	21.7	10.2	27.06	63.7	20.6	14.7	1.0
Heinz 1350	83.7	11.4	35.6	28.6	24.4	21.42	74.4	17.6	7.7	0.3
Glamour	93.1	21.5	41.5	18.6	18.4	19.88	66.3	22.0	11.0	0.7

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Table II - Tomato Variety Evaluation - Objective Quality and Chemical Analysis - Raw Product Data - Columbus, 1961

		NO. 1's				NO. 2's COLOR				FIELD RUN			
VARIETY	DATE	AGTRON	% CITRIC ACID	pH	VIT.C	AGTRON	% CITRIC ACID	pH	VIT.C	AGTRON	%CITRIC ACID	pH	VIT.C
Rutgers	9/6	30	6.7	5.1	13.8	52.2	6.7	4.85	15.0	39	6.6	4.1	16.3
	9/12	35	9.6	4.09	13.07	42.0	9.5	4.16	12.8	35	7.1	4.3	17.2
	9/21	31	8.5	4.14	9.0	46.0	9.4	4.1	9.0	50	7.7	4.3	15.0
	X	32.0	8.2	4.44	12.0	46.7	8.5	4.37	12.3	41.3	7.1	4.23	16.2
Heinz 1370	9/6	32	6.6	4.3	15.7	41	6.9	4.2	21.6	42	6.4	4.1	22.8
	9/12	38	7.1	4.3	20.9	52.3	7.0	4.2	17.8	37	7.7	4.3	25.4
	9/21	34	7.6	4.35	17.3	45	7.9	4.2	18.1	43	6.6	4.2	21.7
	X	34.7	7.1	4.32	18.0	46.1	7.27	4.2	19.2	40.7	6.9	4.2	23.3
KC 146	9/6	38	6.8	4.18	23.2	46.0	9.7	4.1	18.2	47	7.6	3.9	23.8
	9/12	37	8.2	4.19	17.9	44	7.3	4.15	18.5	36	7.7	4.3	20.4
	9/21	38	7.2	4.1	21.0	39	7.1	4.1	25.1	40	8.3	4.35	20.2
	X	37.7	7.4	4.16	20.7	43.0	8.0	4.12	20.6	41.0	7.9	4.18	21.5
Fireball	9/6	24	6.6	4.3	16.3	47	5.4	4.4	13.8	23	6.3	4.5	15.0
	9/12	-	-	-	-	-	-	-	-	39.5	7.4	4.2	15.9
	9/21	-	-	-	-	-	-	-	-	-	-	-	-
	X	24.0	6.6	4.3	16.3	47	5.4	4.4	13.8	31.3	6.9	4.35	15.5
C - 52	9/6	39	6.9	4.2	13.6	34.0	7.8	4.1	12.3	27	6.8	4.3	20.4
	9/12	28	7.5	4.1	14.0	54	9.5	4.2	13.4	55	8.4	4.12	22.5
	9/21	40	7.5	4.05	13.5	43	8.3	4.25	13.5	38	7.9	4.1	15.0
	X	35.7	7.3	4.12	13.7	43.7	8.5	4.18	13.1	40.0	7.7	4.17	19.3
ES 24	9/6	44	8.1	4.1	25.2	48	9.1	4.0	25.5	46	7.0	4.4	27.9
	9/12	34.5	6.9	4.3	23.8	45	6.5	4.4	24.7	49	7.4	4.21	26.6
	9/21	38	7.0	4.2	20.2	51	7.4	4.1	18.7	49	7.6	4.2	25.4
	X	38.8	7.3	4.2	23.1	48.0	7.7	4.17	23.0	48.0	7.3	4.27	26.6

Table II continued - Tomato Variety Evaluation - Objective Quality and Chemical Analysis - Raw Product Data - Columbus, 1961

		NO. 1's				NO. 2's COLOR				FIELD RUN			
VARIETY	DATE	AGTRON	% CITRIC ACID	pH	VIT.C	AGTRON	% CITRIC ACID	pH	VIT.C	AGTRON	% CITRIC ACID	pH	VIT.C
Tecumseh	9/6	26.3	7.8	4.2	16.7	33	8.0	4.1	18.4	-	-	-	-
	9/12	23	7.6	4.16	14.07	37	8.5	4.2	13.7	43	7.5	4.3	15.9
	9/21	31	7.7	4.2	11.2	48	8.0	4.15	12.7	40	7.8	4.22	16.8
	X	26.8	7.7	4.19	14.0	39.3	8.2	4.15	14.9	41.5	7.65	4.26	16.4
Hoytville No. 6	9/6	20	6.2	4.2	19.4	44	-	-	18.7	48	6.3	4.3	23.1
	9/12	34.3	7.0	4.2	17.8	46	7.3	4.19	17.81	43	6.9	4.3	17.8
	9/21	33	6.5	4.5	13.4	37	6.9	4.5	12.6	40	6.2	4.4	16.8
	X	29.1	6.6	4.3	16.9	42.3	7.1	4.35	16.37	43.7	6.5	4.33	19.2
Hotset	9/6	36	8.1	4.0	27.9	55	9.8	3.9	25.2	42	8.0	4.4	28.6
	9/12	27	7.3	4.15	21.0	26	7.9	4.4	24.9	43.7	8.4	4.15	20.3
	9/21	30	8.1	4.0	18.7	38	8.8	4.0	18.9	39	8.8	4.0	20.2
	X	31.0	7.8	4.05	22.5	39.7	8.8	4.1	23.0	41.6	8.4	4.18	23.0
Heinz 1409	9/6	36	7.7	4.1	20.7	49.0	8.5	4.0	23.1	42	7.9	4.6	25.8
	9/12	33.7	8.3	4.16	17.8	49.0	8.3	4.10	19.7	42	8.0	4.29	26.0
	9/21	43	9.1	4.2	19.7	49	8.2	4.3	18.9	44	6.8	4.35	22.5
	X	37.6	8.4	4.15	19.4	49.0	8.3	4.13	20.6	42.7	7.6	4.41	24.8
Heinz 1350	9/6	36	4.5	4.5	23.8	41.0	4.5	4.4	21.8	41	5.0	4.45	19.1
	9/12	29	5.0	4.4	16.6	46.0	4.9	4.3	16.3	43	4.6	4.5	26.5
	9/21	37	4.7	4.4	15.72	58	5.2	4.4	13.0	40	4.6	4.5	17.2
	X	32.7	4.7	4.43	18.7	48.3	4.87	4.7	17.0	41.3	4.7	4.48	20.9
Glamour	9/6	37	6.0	4.4	29.2	41	6.7	4.3	15.0	47	7.0	4.3	21.1
	9/12	29	6.6	4.2	13.4	57	6.8	4.15	10.8	51	6.0	4.35	14.0
	9/21	32	5.8	4.3	10.2	41	5.7	4.3	10.2	-	-	-	-
	X	32.7	6.1	4.3	17.6	46.3	6.4	4.25	12.0	49.0	6.5	4.33	17.6

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Table III - Tomato Variety Evaluation - Subjective, Objective and Chemical Analysis of Tomato Juice (Average of replicates for field run tomatoes - all lots processed by 'cold break' double extract, flash pasteurized.) - Columbus, 1961.

VARIETY	COLOR	CONS.	DEF.	FLAVOR	AGTRON	pH	% CITRIC ACID	VIS.	SOL. SOLIDS	T.S.	GRADE
Rutgers	28.0	12.0	15.0	39.0	42.5	4.2	7.8	39.5	4.75	94.0	A
Heinz 1370	27.0	13.3	15.0	37.0	42.0	4.23	6.8	42.0	4.5	92.3	A
KC 146	28.3	11.75	15.0	36.5	40.0	4.25	6.75	39.0	4.88	91.5	A
Fireball	29.0	12.0	15.0	30.0*	40.0	4.3	7.0	39.0	5.0	86.0	C
C - 52	29.5	13.0	15.0	32.5*	36.0	4.15	7.8	42.0	4.75	90.0	C
ES - 24	27.5	13.0	15.0	31.5*	46.0	4.15	7.6	40.5	4.5	87.0	C
Tecumseh	28.5	11.5	15.0	37.5	40.0	4.2	7.45	38.5	4.75	92.5	A
Hoytville No. 6	28.5	12.0	15.0	35.5	41.0	4.3	6.35	39.0	5.0	91.0	A
Hotset	28.5	12.0	15.0	35.0	42.0	4.0	8.2	39.0	4.75	90.5	A
Heinz 1490	28.0	13.0	15.0	33.0	42.5	4.25	7.35	41.0	4.75	89.0	A
Heinz 1350	29.0	14.0	15.0	35.0	37.3	4.47	4.83	48.3	4.16	93.0	A
Glamour	27.0	13.0	15.0	40.0	44.0	4.2	7.6	40.0	5.5	95.0	A

* Indicates limiting rule.

Table IV - Tomato Variety Evaluation - Subjective, Objective and Chemical Analysis of Canned Tomatoes (all lots processed from field run tomatoes) - Columbus, 1961.

VARIETY	pH	% CITRIC ACID	DR. WT.	DR.WT. POINTS	WHOLE-NESS	COLOR	ABS. OF DEF.	TOTAL	GRADE	REMARKS
Rutgers	4.17	7.23	12.61	20.0	17.55	27.89	28.89	94.33	A	
Heinz 1370	4.23	6.20	12.53	20.0	18.67	28.67	28.55	95.89	A	
KC 146	4.17	6.47	12.31	20.0	16.78	28.0	29.0	93.78	A	Some core present
Fireball	4.4	5.5	12.42	20.0	18.33	28.0	29.67	96.0	A	
C - 52	4.2	7.0	12.33	20.0	18.33	30.0	26.0*	94.33	B	Core present
ES 24	4.2	6.87	12.45	20.0	17.78	26.55*	28.89	93.22	B	Small amount core present & yellow shoulders
Tecumseh	4.3	6.4	11.33	18.0	14.33*	29.33	30.0	91.66	C	
Hoytville No. 6	4.38	6.1	12.08	19.33	18.22	27.45	28.44	93.44	A	
Hotset	4.1	7.9	11.58	19.0	18.0	28.67	27.33	93.0	A	Some core present
Heinz 1409	4.23	6.27	12.66	20.0	18.11	28.22	28.78	95.11	A	
Heinz 1350	4.5	4.2	12.75	20.0	18.22	27.89	29.11	95.22	A	
Glamour	4.32	5.77	12.27	20.0	17.67	26.11*	28.78	92.56	B	

* Indicates limiting rule.

EVALUATION OF SNAP BEAN VARIETIES FOR PROCESSING - 1961

by Wilbur A. Gould
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Snap beans were grown on the Horticultural farm at The Ohio State University. Seven varieties of beans were planted at 200 foot rows, 36 inches apart with the seed placed two to three inches apart in the row. The beans were grown under accepted commercial practices for this region. Two harvests were made of each variety. The beans were brought to the Fruit and Vegetable Processing and Technology Pilot Plant where they were prepared for canning and freezing. The beans were snipped mechanically, size graded, washed, and blanched in live steam for either 2½ or 3 minutes depending on the sieve size. They were immediately cooled and twelve ounces were filled in #303 plain tin cans. Each variety was further segregated into two lots. One lot covered with boiling distilled water, sealed, and retort processed while the other lot was sealed and frozen.

Quality was determined as follows (the results as reported in the following tables are the average values where applicable):

Number of plants per 100 feet - The actual number of plants in 100 feet was counted as the plants were pulled for harvest.

Yield - The beans were weighed to determine the yield.

Number per pound - The number of pods in a one pound field run sample was counted.

Percent sieve size - Sieve size was determined by measuring the diameter of the pod perpendicular to the sutures. The sieve sizes of a one pound field run sample were determined and weighed. The percent of each sieve size was then calculated.

Range of pod length - Pod length was determined by measuring the length of 20 pods and was reported as the range from shortest to longest pods.

Percent seeds by sieve size - 100 grams of pods for each sieve size were deseeded and the seeds were weighed. The percent seeds was then calculated.

Percent by weight seeds - The canned and frozen products were examined in the same manner as described for percent seeds by sieve size.

Percent fiber - The fiber content was determined by the sodium hydroxide digestion method of the Food and Drug Administration.

U.S. Grades for Canned Snap Beans - The grade was determined in accordance with the U.S. Standard for Grades of Canned Green and Wax Beans.

U.S. Grades for Frozen Snap Beans - The grade was determined in accordance with the U.S. Standard for Grades of Frozen Green Beans and Frozen Wax Beans.

Seed Source - Seed source is indicated by the following abbreviations:

A - Asgrow
Ha - Harris
Ho - Holmes
FM - Ferry Morse
B - Burpee

Lot number - The lot number of the seed follows the seed source under the variety name.

Table I - Snap Bean Variety Evaluation - Raw Product Data - Columbus - 1961

VARIETY	HARVEST	NO. PLANTS /100 ft.	YIELD (lbs)	NO. /lb.	PERCENT SIEVE SIZE 1	2	3	4	5	6
Harvester	1	1089	64.5	126	6	11	19	33	25	6
A 46769	2	997	85.0	97	4	6	30	35	18	7
Imp. Tendergreen	1	1094	90.0	74	0	2	3	10	23	62
Ha 3264	2	968	120.0	65	1	1	4	9	14	71
Tendercrop	1	985	86.0	112	12	15	27	25	11	10
Ho 178	2	1005	135.5	76	2	1	4	4	22	67
Green Cluster	1	844	34.5	148	14	8	13	16	28	21
FM	2	680	71.0	81	1	1	3	27	40	28
Culture 187C	1	512	25.0	65	1	1	2	9	19	68
FM	2	475	51.0	57	.5	1	.5	4	13	81
Greencrop	1	875	96.5	61	4	0	6	9	11	70
B 22643 - 60	2	917	141.5	51	.5	0	3	.5	4	92
Pearlgreen	1	270*	35.0	102	13	14	23	31	9	10
B BPE29751	2	286*	56.0	55	.5	0	.5	8	40	51

* 50 foot rows

VARIETY	HARVEST	POD LENGTH (Range)	PERCENT SEEDS BY SIEVE SIZE 1	2	3	4	5	6
Harvester	1	3.4 - 4.6	1.8	1.7	1.9	1.1	4.5	16.0
A 46769	2	3.1 - 5.3	.3	.2	7.4	10.4	10.0	18.9
Imp. Tendergreen	1	3.8 - 4.8	0	2.0	15.8	14.1	17.7	11.9
Ha 3264	2	3.3 - 4.8	2.9	6.5	10.0	8.6	11.1	21.4
Tendercrop	1	2.0 - 4.5	-	3.2	1.4	2.7	3.7	5.0
Ho 178	2	2.5 - 4.0	10.4	10.0	19.0	22.0	19.4	10.7
Green Cluster	1	2.8 - 5.0	-	.6	1.6	2.4	3.3	4.8
FM	2	3.0 - 4.3	7.7	3.6	21.7	10.0	8.6	23.9
Culture 187C	1	3.3 - 5.8	4.3	-	1.3	.3	1.5	4.1
FM	2	3.5 - 5.0	-	-	.5	.1	.1	7.9
Greencrop	1	4.3 - 6.6	-	0	1.9	1.8	2.5	3.4
B 22643 - 60	2	4.2 - 5.8	.7	0	.3	.9	.2	.1
Pearlgreen	1	3.5 - 4.8	.2	.3	.2	.3	1.0	.7
B BPE29751	2	3.0 - 5.5	-	0	7.4	1.6	5.2	13.2

Table II - Snap Bean Variety Evaluation - Canned Snap Beans, Columbus - 1961

					U.S. GRADE					
VARIETY	HARVEST	SIEVE SIZE	% BY WT.OF SEEDS	% FIBER	CLEARNESS OF LIQUOR	COLOR	ABS. OF DEFECTS	CHARACTER	TOTAL SCORE	GRADE
Harvester	1	1-3	3.0	-	10	14	33	39	96	A
		4-6	5.0	-	10	14	34	37	95	A
	2	1-3	7.0	.005	10	14	30**	36	90	A
		4-6	10.0	.033	10	12	31	33*	86	B
Improved Tendergreen	1	1-3	9.0	.12	9	15	32	39	95	A
		4-6	5.0	.16*	6*	14	31	27*	78	D
	2	1-3	5.5		9	14	34	37	94	A
		4-6	17.4	.09	7	14	33	30*	84	C
Tendercrop	1	1-3	2.0	.12	9	14	33	39	95	A
		4-6	4.0	.07	9	14	34	38	95	A
	2	1-3	4.3	.04	9	14	32	38	93	A
		4-6	8.0	.01	9	14	33	35	91	A
Green Cluster	1	1-3	3.0	.08	10	14	31	39	94	A
		4-6	4.0	.005	9	14	34	38	95	A
	2	1-3	4.0	.115	9	12	31	38	90	A
		4-6	10.0	.28*	10	14	34	27*	85	D
Culture 187C	1	1-3	2.0	.105	9	13	31	39	92	A
		4-6	4.0	.09	10	13	32	38	93	A
	2	1-3	1.0		9	14	32	40	95	A
		4-6	7.0	.02	10	12	30**	36	88	B
Greencrop	1	1-3	3.0	.12	10	12	33	39	94	A
		4-6	4.0	.12	10	14	30**	38	92	B
	2	1-3	3.0	.12	10	13	33	39	95	A
		4-6	9.0	.13	10	14	33	34*	91	B
Pearlgreen	1	1-3	2.0	.12	10	14	32	39	95	A
		4-6	5.0	.08	9	14	33	37	93	A
	2	4-6	9.0	.09	9	14	33	34*	90	B

* Limit rule - Beans falling in this classification cannot earn higher grade regardless of total score.

** Partial limiting rule - Does not apply to damage from mechanical injury, such as broken beans.

Table III - Snap Bean Variety Evaluation - Frozen Snap Beans, Columbus - 1961

VARIETY	HARVEST	SIEVE SIZE	% BY WT. OF SEEDS	% FIBER	U.S. GRADE COLOR	ABS. OF DEFECTS	CHARACTER	TOTAL SCORE	GRADE
Harvester	1	1-3	4.0	-	19	36	38	93	A
		4-6	4.0	.03	18	37	38	93	A
	2	1-3	7.2	-	19	34**	35***	88	B
		4-6	10.5	.08	18	33**	31*	82	C
Improved Tendergreen	1	1-3	5.4	-	19	38	37	94	A
		4-6	14.0	.03	18	30*	28*	76	C
	2	1-3	5.5	-	18	33**	36	87	B
		4-6	2.3	.01	17*	35**	28*	80	C
Tendercrop	1	1-3	3.0	-	20	37	39	96	A
		4-6	3.0	.045	18	36	39	93	A
	2	1-3	3.0	-	20	39	39	98	A
		4-6	5.0	.005	19	37	37	93	A
Green Cluster	1	1-3	2.0	-	19	37	39	95	A
		4-6	7.0	.075	19	33**	35	87	B
	2	1-3	4.0	-	18	36	38	92	A
		4-6	10.0	.005	18	36	32***	86	B
Culture 187C	1	1-3	2.0	-	17*	36	39	92	B
		4-6	4.3	.015	17*	36	38	91	B
	2	1-3	2.0	-	19	33**	39	91	B
		4-6	7.0	.01	18	30*	35***	83	C
Greencrop	1	1-3	2.0	-	19	33**	39	91	B
		4-6	3.0	.02	18	35**	39	92	B
	2	1-3	3.0	-	18	33**	39	90	B
		4-6	8.0	.01	18	34**	34***	86	B
Pearlgreen	1	1-3	2.0	-	18	38	39	95	A
		4-6	6.0	-	18	38	36	92	A
	2	4-6	10.0	.06	18	36	32***	96	B

Limiting rules:

* Samples with these scores may not be of higher grade

** Samples scoring here for blemished or seriously blemished beans may not be higher than Grade B.

*** Samples scoring here, except for sliced lengthwise, may not be higher than Grade B.

EVALUATION OF SWEET CORN VARIETIES FOR PROCESSING

1 9 6 1

by J. R. Geisman and W. A. Gould

Fruit and Vegetable Processing and Technology Division, Department of Horticulture, OAES

The sweet corn evaluation trials included five varieties. The corn was planted May 16, June 2, and June 8, 1961. Each variety was harvested at various stages of maturity and processed as cream style corn. The standard formula, based on fifty pounds of corn, was as follows:

corn - 78.0%
water - 18.5%
sugar - 5.0%
salt - 0.5%
starch- 1.5%

The formula was varied by five pound increments of water to each batch. The initial determination of the amount of water to add was based on the specific gravity of the corn.

Quality was determined as follows (the results as reported in the following tables are the average values, where applicable):

Growing Days - Actual number of days from planting to harvest.

Growth Degree Days - Calculated, using 50°F. as the base temperature, from the Columbus, Ohio, Weather Bureau Data.

Specific Gravity - Determined on a 100 gram sample of cut corn as follows:

$$\text{Specific gravity} = \frac{\text{wt. of corn in air} \times \text{specific gravity of water}}{\text{wt. of corn in air} - \text{wt. of corn in water}}$$

Percent AIS - Determined on a ten gram sample in accordance with the F and DA Alcohol Insoluble Solids (AIS) method for the minimum standards of Quality for Canned Sweet Corn.

Average Kernel Diameter - Determined by measuring the total width of twenty kernels and dividing by twenty (20).

Consistency - Determined with the aid of the Adams Consistometer. The Adams Consistometer values range from 1 (thin) to 18 (thick). The filler values were determined on hot samples at the time of filling and the canned values were determined after approximately three months storage.

Percent WDR - The Washed Drained Residue (WDR) was determined by washing a sample of corn on a eight mesh screen and weighing the residue remaining on the screen and calculating the percent remaining on the screen.

U.S. Grade - The U.S. Grade was determined in accordance with the U.S. Standards for Grades of Canned Cream Style Corn.

Ave. Ear Width - Determined by measuring the total width of twenty ears and dividing the total by twenty.

Ave. Ear Length - Determined by measuring the total length of twenty ears and dividing the total by twenty.

Seed Source and Lot Number - The seed source and lot number are listed below each variety in Table 1. The abbreviations are as follows:

A - Asgrow
ML - Michael-Leonard SRS
FM - Ferry-Morse
L - Letherman's

Batch number - The batch number indicated in Table 2 refers to the following formula:

1 = Standard formula
2 = Standard formula + 5 lbs. water
3 = Standard formula + 10 lbs. water
4 = Standard formula - 5 lbs. water
5 = Standard formula - 10 lbs. water
6 = Standard formula + 15 lbs. water
7 = Standard formula + 20 lbs. water
8 = Standard formula + 25 lbs. water

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Table 1 - Raw Product Data for Sweet Corn Varieties by Harvests - Columbus, 1961

VARIETY	HARVEST DATE	GROWING DAYS	GROWTH DEGREE DAYS	SPECIFIC GRAVITY	% AIS	AVERAGE KERNEL DIAMETER	AVE. EAR LENGTH	AVE. EAR DIAMETER
Deep Gold	8/18	94	1698.0	1.090	19.97	.29"	7.7"	1.9"
(L 1-106)	8/31	90	1862.5	1.087	13.46	.285	7.825	1.9
	9/1	91	1889.0	1.0865	19.95	.315	7.95	1.9
	9/8	92	2004.5	1.106	28.40	.32	7.65	2.1
	9/11	95	2082.0	1.110	26.36	.33	8.125	2.15
Merit	8/14	90	1609.5	1.063	12.09	.28	8.18	1.9
(A 63526F3D	8/18	94	1698.0	1.066	18.72	.31	8.3	2.0
	8/25	84	1722.5	1.051	7.07	.35	8.25	1.875
	8/31	90	1862.3	1.092	20.79	.315	7.85	2.05
	9/5	89	1926.0	1.0985	23.59	.36	8.3	2.125
	9/8	92	2004.5	1.112		.34	8.3	2.125
Hybrid 105	8/14	90	1609.5	1.055	14.71	.31	7.7	1.65
(FM 89794)	8/18	94	1698.0	1.096	23.36	.33	7.25	1.6
	8/31	84	1722.5	1.105	21.23	.326	7.65	1.7
	9/1	90	1862.5	1.097	26.76	.34	7.725	1.65
	9/5	89	1926.0	1.1225	28.64	.32	7.85	1.7
	9/8	92	2004.5	1.143	30.97	.36	7.65	1.775
Golden Sensation	8-22	98	1778.0	1.075	12.29	.37	8.7	1.9
(ML 20569)	8/25	84	1722.5	1.057	15.52	.34	8.45	1.8
	9/1	91	1889.0	1.0715	16.72	.385	8.85	1.8
	9/5	89	1926.0	1.0815	23.14	.375	8.55	2.0
Deep Gold (A 43036F32)	9/11	95	2082.0	1.115	27.60	.32	7.95	2.15

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Table 2 - U. S. D. A. Grades by Factors of Quality and Other Quality Data for Each Variety at Each Harvest for Canned Cream Style Corn - Columbus, 1961

VARIETY	BATCH NO.	HARVEST	U.S.D.A. Grade Factors: COLOR	CONSISTENCY	ABSENCE OF DEFECTS	TENDERNESS AND MATURITY	FLAVOR	TOTAL SCORE	GRADE	Adams Consistency: FILLER	CANNED	% WDR
Deep Gold	1	8/18	10	14**	20	30	20	94	C	0	0	58
	1	8/31	10	15**	20	30	20	95	C	> 0	1.5	24
	1	9/1	10	16	20	30	20	96	A	0	5.5	56
	2	9/1	10	15**	20	30	20	95	C	4.5	2.0	48
	1	9/8	8	17	20	25*	18	88	B	1.25	4.75	50
	2	9/8	9	17	20	25*	19	90	B	0	4	60
	3	9/8	9	16	20	24*	18	87	B	>0	2	64
	1	9/11	6*	18	20	23**	16	83	C	0.5	4	62
	2	9/11	9	18	19	22**	15**	83	C	4.25	8.5	66
	3	9/11	10	19	20	22**	15**	86	C	4.75	6	72
Merit	2	8/14	7*	16	20	30	13**	86	D	>0	2	64
	1	8/14	7*	17	20	30	13**	83	D	0	5	82
	1	8/18	10	18	20	29	20	97	A	2	8	69
	2	8/18	8	16	20	28	18	90	A	0	4	50
	3	8/18	8	14**	20	28	19	89	C	>0	0	50
	1	8/25	6*	14**	20	28	14**	82	C	0	2	56
	2	8/25	7*	16	20	28	15**	86	C	>0	2	42
	1	8/31	10	18	20	25*	18	91	B	>0	2.5	46
	2	8/31	10	15**	20	26*	18	89	C	>0	0	54
	4	8/31	10	16	20	25*	17	88	B	0	4	71
	5	8/31	10	19	20	23**	16	88	C	4.0	8	51
	1	9/5	10	20	20	24*	18	92	B	8.0	5.5	72
	2	9/5	10	20	20	23**	16	89	C	4.75	6.25	70
	3	9/5	10	20	20	23**	17	90	C	3.75	2.5	61
	6	9/5	10	20	20	23**	16	89	C	0	0	52
	7	9/5	9	14**	20	28	20	91	C	>0	0	44
	1	9/8	10	18	20	25*	20	93	B	7.0	7.5	62
	2	9/8	10	19	20	25*	20	94	B	6.75	7.75	66
	3	9/8	9	18	20	27	20	94	A	4.75	4.5	64
	6	9/8	8	16	20	25*	18	87	B	.5	2.75	52
	7	9/8	8	16	20	24*	18	86	B	>0	1.75	66

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Table 2, continued.

VARIETY	BATCH NO.	HARVEST	U.S.D.A. Grade Factors: COLOR	CONSISTENCY	ABSENCE OF DEFECTS	TENDERNESS AND MATURITY	FLAVOR	TOTAL SCORE	GRADE	Adams Consistency: FILLER	CANNED	% WDR
Hybrid 105	1	8/14	5**	17	18	30	13**	83	D	7.5	6.25	44
	1	8/18	9	19	20	28	20	96	A	7.0	10	68
	2	8/18	8	16	20	28	20	92	A	6.5	3	36
	3	8/18	8	18	20	27	20	93	A	0	5	54
	2	8/31	9	19	20	27	20	95	A	2	5.5	54
	1	8/31	9	20	20	24*	20	93	B	7	8.5	60
	1	9/1	10	20	20	25*	20	95	B	7	10.5	54
	2	9/1	9	16	20	27	20	92	A	5.25	6	40
	3	9/1	10	18	20	25*	19	92	B	4	7	48
	1	9/5	9	18	20	24**	18	89	B	5	9	54
	2	9/5	9	17	20	24*	18	88	B	4	6.25	50
	3	9/5	8	16	20	25*	18	87	B	0.25	2	62
	1	9/8	9	19	20	24*	18	90	B	9	10.5	64
	2	9/8	10	19	20	26*	19	94	B	6	2.75	48
	3	9/8	9	17	20	24*	17	87	B	5.5	6.5	47
Golden Sensation	1	8/22	6*	15**	20	30	14**	85	C	>0	1.75	52
	2	8/22	6*	15**	20	30	14**	85	C	0	4.5	64
	1	8/25	7*	18	20	30	17	92	B	3.5	7.5	60
	2	8/25	8	18	20	29	20	95	A	1	6.25	58
	3	8/25	8	18	20	29	20	95	A	0	4.75	58
	1	9/1	9	18	20	29	20	96	A	.75	5.25	50
	2	9/1	8	18	20	28	19	93	A	0.[illegible]	3.5	56
	1	9/5	8	19	20	28	19	94	A	.75	4	48
	2	9/5	9	18	20	28	20	95	A	4.75	4	44
	3	9/5	8	17	20	26*	18	82	B	2.25	2.5	44
	6	9/5	9	17	20	24*	18	88	B	>0	2.25	63
Deep Gold	1	9/11	8	18	20	24*	18	88	B	7.5	10.75	51
	2	9/11	8	18	20	23**	17	86	C	6.75	8.5	52
	3	9/11	8	18	20	24**	18	88	B	4.25	5.25	54
	6	9/11	8	17	20	23**	16	84	C	0	4.75	54
	7	9/11	8	17	20	23**	15**	83	C	>0	3.25	46
	8	9/11	8	16	20	24*	16	84	B	>0	1	48

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EVALUATION OF PEACH VARIETIES FOR CANNING

by D. R. Davis, Fruit and Vegetable Processing & Technology Division, Department of Horticulture, O.A.E.S.

The evaluation of freestone peach varieties for processing has been in progress for many years at the Experiment Station. Past evaluations, however, have been concerned mainly with the frozen product and the small amount of work devoted to the canning aspect concerned only canned sliced peaches. In reality, practically all canned freestone peaches available in the retail stores are canned as halves and not sliced. In 1960 a study was initiated to evaluate the quality of canned halves of all the important peach varieties grown in Ohio. Rather than include a few varieties and obtain complete detailed objective and subjective analysis, it was decided to evaluate all important and promising varieties grown at the Experiment Station and then eliminate those varieties which did not appear suitable for canning.

The variety evaluations for the 1960 season included 4 white varieties, 21 yellow freestone varieties and 3 clingstone varieties. The clingstone varieties (Ambergem, Vivian, and Coronado) were considered unsatisfactory for processing.

The results of the analysis of the white and yellow freestone varieties are given in Table I. The subjective analysis was determined by two staff members rather than a taste panel since the main objective was to eliminate the poorer varieties. However, the results show that there were few poor varieties.

Generally, the white peaches did not make a high quality pack. If Elberta is used as the standard for the yellow freestone varieties, as is usually done, practically all varieties were rated as good as or better than Elberta. Blake was the only variety considered to be unsuitable for processing and will not be used in future evaluations.

Generally the peaches packed in a 60% sucrose solution were too sweet and rated lower than those packed in a 40% sucrose solution.

It should be cautioned that these statements are based on the results from only one season. This study is to be continued for several seasons before definite recommendations are made.

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TABLE I - Peach Variety Evaluation - Analysis of Canned Peach Halves Packed In 40% Sucrose Solution - Wooster, 1960.

VARIETY		CUT-OUT BRIX	GRADE FACTORS COLOR	CHARACTER	GRADE	FLAVOR**	REMARKS
White Freestone:							
Stoner		21	17*	28	B	7	Brown pit area
Georgia Belle	(1)	19	19	29	A	7.5	Dark pit area
	(2)	21	18	28	B	6	Stringy, sweet
Cumberland		20	18	27	C	7	Greenish, soft
Redrose	(1)	18	18	27	B	6.5	Soft, acid
	(2)	18	18	27	B	7	Pale color, acid
Yellow Freestone:							
USDA 7-1029***		18	20	28	A	7.5	Excellent
Coronet****		19	18	29	B	8.5	Dull color
Keystone		20	18	27	B	8.5	Soft
Fairhaven	(1)	18	19	28	A	7.5	
Redhaven	(2)	12	16*	27	C	6	Brownish, bland
Sunhigh		21	18	28	B	7.5	Tough, bland
Redglobe		21	17*	28	B	7.5	Bland
Prairie Dawn****		20	19	27	A	7	Nut-like flavor
Elberta	(1)	21	17*	28	B	7	Dark pit area
	(2)	22	16*	27	B	7	Dark pit area
Sunhaven***,****	(1)	22	19	28	A	9	Excellent
	(2)	20	18	28	A	8.5	Excellent
Halehaven	(1)	19	17*	27	B	7.5	Pale color, soft
	(2)	20	20	29	A	7.5	
Golden Jubilee	(1)	18	18	26*	C	5.5	Pale, soft, acid
	(2)	19	20	28	A	7	Soft
Ranger		20	19	27	B	7	Soft, ragged
Triogem***		20	19	27	A	8	
Richhaven***	(1)	20	18	28	A	8.5	Dark pit area
	(2)	19	19	28	A	8	Dark pit area
	(3)	18	18	28	B	6	Too acid
Poppy		18	19	27	A	8	Pale, ragged
Summercrest		19	18	27	B	7	Stringy, brownish
Blake		20	12*	28	D	7.5	Purple pit area
Kalhaven	(1)	20	17*	28	B	6.5	Dark pits, bland
	(2)	22	17*	27	B	6.5	Dark pits, bland
Redskin		21	17*	27	B	7.5	Dark pits, bland
FV 131-50***		21	19	28	A	9	Excellent

* Limiting rule - samples with these scores may not be of higher grade.
** Flavor scores were rated from 1 (poor) to 9 (excellent).
*** Variety is excellent for canning as halves in 40% sucrose solution.
**** Variety is excellent for canning as halves in 60% sucrose solution.

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QUALITY EVALUATION OF FRUIT JUICE BLENDS

by D. R. Davis, Fruit and Vegetable Processing & Technology
Division, Department of Horticulture, O.A.E.S.

In a continuation of the fruit juice blend study, over 75 different blends were evaluated in 1960. Most of these blends incorporated as a base a cider blend consisting of Stayman Winesap, Jonathan, Rome Beauty, Red delicious, and Golden Delicious apple varieties. The cider was blended with the juice from Concord grapes, Montmorency cherries, strawberries, lemons, and limes at concentrations ranging from 50% cider to 90% cider. The strawberry juice was obtained from commercially frozen 4-plus-1 strawberries. Each fruit juice blend was further adjusted to a soluble solids content equal to 3/4 and 1/2 of the soluble solids content of the original juice blend. This adjustment was done by adding a suitable amount of water in an effort to determine the extent to which the soluble solids could be reduced before the resulting "ade" or "punch" would be considered unacceptable.

Both the fresh and pasteurized fruit juice blends were presented to a taste panel consisting of 8 to 14 members and each drink was presented separately and in random order so they could not be compared with one another. Each juice blend was given a flavor score ranging from 1 (poor) to 9 (excellent) and all flavor scores averaging below 5 were considered to be unacceptable.

The taste panel results, given in Table I, show that all but two of the full strength pasteurized fruit juice blends were considered to be highly acceptable. The pasteurized apple-strawberry blends, even when the solids were reduced to 1/2 that of the pure juice blend, were preferred over all other blends, including the plain apple juice. Apparently the flavor of the fresh fruit juice blend cannot be used as a guide in determining the acceptability of the pasteurized juice blend, as shown by the difference in the flavor scores between the fresh and pasteurized juices or some of the blends.

Generally, the fruit juice blends in which the soluble solids were reduced could be detected. Although some of the 3/4 soluble solids drinks had an acceptable flavor, they were considered "watery" or lacking in "body" by the panel. Those drinks in which the soluble solids were reduced to 1/2 were all rated unacceptable except one of the apple-strawberry blends where the flavor was considered "delicate" and "diluted".

TABLE I - Analysis of Fresh and Pasteurized Fruit Juice Blends

JUICE BLEND	DILUTION FACTOR		pH	% TOTAL ACIDS	SOLUBLE SOLIDS	SUGAR/ACID RATIO	FLAVOR*
Cider	0	Fresh	3.6	0.46	14.5	31.4	6.7
		Past.	3.6	0.49	14.3	29.0	6.6
1/2 Apple, 1/2 Grape	0	Fresh	3.4	0.64	14.3	22.3	7.0
		Past.	3.5	0.63	14.9	23.7	5.6
	1/4	Fresh	3.5	0.49	10.6	21.5	5.9
		Past.	3.6	0.41	12.5	30.6	5.9
	1/2	Fresh	3.5	0.34	7.0	20.2	5.3
		Past.	3.6	0.33	7.3	21.9	4.2
3/4 Apple, 1/4 Grape	0	Fresh	3.4	0.55	13.8	25.0	7.0
		Past.	3.6	0.54	13.8	25.3	6.2
	1/4	Fresh	3.5	0.42	10.7	25.7	6.6
		Past.	3.7	0.40	10.0	25.2	5.8
	1/2	Fresh	3.6	0.29	7.1	24.6	5.7
		Past.	3.6	0.29	7.8	26.5	4.6

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TABLE I - Analysis of Fresh and Pasteurized Fruit Juice Blends - continued.

JUICE BLEND	DILUTION FACTOR		pH	% TOTAL ACIDS	SOLUBLE SOLIDS	SUGAR/ACID RATIO	FLAVOR*
1/2 Apple, 1/2 Sour Cherry	0	Fresh	3.5	0.76	21.0	27.5	6 .2
		Past.	3.5	0.78	20.5	26.4	6.0
	1/4	Fresh	3.5	0.55	15.0	27.2	5.9
		Past.	3.7	0.54	15.2	27.9	5.7
	1/2	Fresh	3.5	0.38	10.3	26.8	4.7
		Past.	3.7	0.40	10.2	25.3	5.8
3/4 Apple, 1/4 Sour Cherry	0	Fresh	3.4	0.62	17.5	28.1	5.1
		Past.	3.6	0.62	16.8	27.3	6.7
	1/4	Fresh	3.5	0.43	11.5	26.8	5.4
		Past.	3.6	0.47	13.0	27.4	4.6
	1/2	Fresh	3.5	0.33	9.0	27.0	3.6
		Past.	3.5	0.34	9.0	26.0	4.5
9/10 Apple, 1/10 Sour Cherry	0	Fresh	3.5	0.53	14.8	28.2	6.4
		Past.	3.7	0.55	9.6	17.4	7.0
	1/4	Fresh	3.5	0.41	11.0	26.8	6.4
		Past.	3.6	0.43	11.8	27.6	5.6
	1/2	Fresh	3.5	0.28	7.5	26.6	3.2
		Past.	3.6	0.29	7.2	25.3	5.6
3/4 Apple, 1/4 Strawberry	0	Fresh	3.6	0.54	16.8	30.8	7.7
		Past.	3.6	0.54	16.0	29.3	7.3
	1/4	Fresh	3.6	0.41	12.5	30.5	7.4
		Past.	3.7	0.41	11.8	28.8	6.8
	1/2	Fresh	3.6	0.27	8.5	31.6	5.7
		Past.	3.7	0.28	8.0	28.4	7.2
9/10 Apple, 1/10 Strawberry	0	Fresh	3.5	0.49	16.8	30.8	7.9
		Past.	3.6	0.49	14.9	30.2	7.1
	1/4	Fresh	3.5	0.38	12.5	30.5	7.6
		Past.	3.7	0.40	11.5	28.9	5.9
	1/2	Fresh	3.6	0.25	8.5	31.6	5.7
		Past.	3.7	0.27	7.2	26.7	4.7
95% Apple, 5% Lemon	0	Fresh	3.3	0.69	13.5	19.7	5.1
		Past.	3.4	0.74	13.2	17.9	6.9
	1/4	Fresh	3.3	0.52	10.0	19.2	6.3
		Past.	3.5	0.53	9.5	17.9	5.7
	1/2	Fresh	3.4	0.34	6.2	18.3	3.0
		Past.	3.5	0.37	6.2	17.0	4.3
98% Apple. 2% Lemon	0	Fresh	3.4	0.56	13.7	24.3	6.6
		Past.	3.6	0.54	12.0	22.0	6.5
	1/4	Fresh	3.4	0.43	10.2	23.8	5.7
		Past.	3.5	0.42	9.5	22.8	6.4
	1/2	Fresh	3.5	0.29	6.9	23.4	3.8
		Past.	3.6	0.29	6.6	22.4	4.9

* Flavor scores were rated from 1 (poor) to 9 (excellent).

THE EFFECT OF SALT, SUCROSE, AND CITRIC ACID ADDITIONS ON THE FLAVOR OF TOMATO JUICE

by Natholyn Dalton and Wilbur A. Gould, Fruit and Vegetable Processing & Technology Division, Department of Horticulture, O.S.U. and O.A.E.S.

This study is an attempt to improve the flavor of tomato juice. Although progress toward successful chemical assay of flavor has been made, the time will probably never come when taste panels will be completely abolished. In this study a ten-member taste panel was used to score the tomato juice according to preference.

To twelve different tomato varieties, varying degrees of salt, sucrose, and citric acid were added to the juice. Salt levels included 60 and 90 grains. Citric acid levels included (1) no acid, (2) .8 gram which lowered the pH approximately .3 of a pH unit and, (3) 1.6 grams which lowered the pH approximately .6 of a pH unit. Sucrose levels included (1) no sucrose, (2) 6.1 grams which raised the soluble solids approximately four percent. These variables were used both separately and in combination with each other to determine whether or not the panel could detect a difference in flavor. The juice was packed in number 303 plain tin and fruit enamel cans.

The chemical analysis included total acid determined by direct titration and calculated as percent citric acid, pH determined with the Beckman zeromatic pH meter, percent soluble solids determined from the refractive indice using the Abbe 56 refractometer, and percent salt as determined by the Mohr method. Agtron "F" values were also determined using 70 as a standard.

A series of taste panels were conducted to determine the acceptability of different varieties at varying levels of salt, sucrose, and citric acid. The rating scale was from 1 to 10 with 1 being very poor and 10 excellent. Average panel scores for the various varieties and additives are shown in Table I.

TABLE I - Average Taste Panel (ten-member) Scores For 11 Varieties of Tomato Juice With Various Levels of Salt, Sucrose, and Citric Acid Added

VARIETY	CONTROL	+ 30 gr. SALT	+ 2% S.S.	+ 4% S.S.	-.3 pH UNIT	-.6 pH UNIT
Rutgers	5.2	5.3	5.5	5.1	5.5	5.3
Heinz 1370	6.2	6.4	7.1	7.0	7.1	5.9
KC 146	6.1	5.9	6.4	8.1	6.4	5.6
C 52	7.6	7.0	7.7	7.9	7.7	7.0
ES 24	5.8	5.3	8.0	8.9	8.0	4.5
Tecumseh	7.2	6.4	7.6	7.9	7.9	6.6
Hoytville #6	6.1	7.1	6.0	6.4	6.0	7.7
Hotset	7.4	6.5	7.8	7.4	7.8	7.5
Heinz 1409	6.6	5.1	7.8	8.7	7.5	5.6
Heinz 1350	4.0	4.7	5.3	7.2	5.3	5.3
Glamour	6.6	5.9	5.9	7.7	5.9	7.2
Average Score	6.2	5.9	6.8	7.4	6.8	6.2

Triangle tests were then conducted to determine whether or not proven chemical variables were significant to the tasters. Preliminary tests have indicated that panel members were able to distinguish an addition of 30 grains of salt when no sucrose or acid were added. However, there were preferences both for and against the added salt. Panel members were also able to distinguish both a two and four percent increase in soluble solids and a -.3 and -.6 pH unit decrease. With the addition of salt and sugar, the panel was unable to distinguish a 30 grain increase in salt.

FLAVOR STUDIES WITH SAUERKRAUT

by S. S. Verma and J. R. Geisman, Fruit and Vegetable Processing & Technology Division, Department of Horticulture, O.S.U. and O.A.E.S.

A decline in the consumption of sauerkraut prompted a study to develop new flavors and uses for kraut. The main consumer objections were: (1) flavor too sour and (2) unpleasant aroma. In order to overcome these objections, the acidity was reduced and various amounts of corn syrup and garlic were added.

Samples were processed at 1.0 and 1.5% acidity. For both acid concentrations, corn syrup solids from 10° to 30° Brix by 5 increments were added to the kraut. In addition, garlic concentrate from 0.04 to 0.24 percent by weight by 0.05% increments was added to each corn syrup and acid combinations. The results of this exploratory investigation indicated that the corn syrup solids should be increased and the garlic content decreased. Therefore, other samples were processed at the two acid levels containing 40°, 50°, and 60° Brix corn syrup and 0.011, 0.023, 0.035, and 0.047% garlic concentrate.

After storage to allow the contents to reach equilibrium, the samples were submitted to a taste panel for flavor analysis. Physical and chemical factors including pH, total acid, salt content, soluble solids, and internal condition of the can were also evaluated.

The results of the flavor evaluations indicated that at 1.0% acidity, both the treated and untreated lots were acceptable while at 1.5% acidity only the treated samples were acceptable. In every case, the samples with corn syrup and garlic added were preferred to the control lots. The treatments which received the highest ratings were:

(1) 1.0% acid plus 40° Brix corn syrup and 0.023% garlic,
(2)* 1.0% acid plus 60° Brix corn syrup and 0.023% garlic,
(3) 1.5% acid plus 40o Brix corn syrup and 0.011% garlic,
(4) 1.5% acid plus 40° Brix corn syrup and 0.047% garlic, and
(5) 1.5% acid plus 60° Brix corn syrup and 0.097% garlic.

The results of the physical and chemical evaluations indicated that the pH and total acidity were not effected by the addition of either corn syrup or garlic concentrate. As would be expected, soluble solids increased in proportion to the amount of added corn syrup, but the addition of garlic had little effect. Salt content in the brine also increased as the corn syrup concentration increased.

Probably one of the most important aspects was the effect on drained weight. The drained weight increased slightly in the control samples, but in the treated lots, the increase was in proportion to the amount of added corn syrup. This would mean lower fill weights to produce the same final net weight as in the untreated lots.

The addition of garlic concentrate produced a slight darkening of the insides of the can. This could probably be overcome by using a resistant enamel as only plain tin cans were used in this study.

In general, it could be concluded that corn syrup solids and garlic concentrate are suitable flavoring ingredients for sauerkraut. Corn syrup from 40° to 60° Brix in combination with 0.011 to 0.047 percent garlic concentrate enhanced the flavor and reduced the objectionable odor.

* It should be noted that treatment (2) was rated the highest by the panel.

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CONTROLLED DRAINED WEIGHTS IN CANNED TOMATOES

by W. A. Schulte and W. A. Gould, Fruit and Vegetable Processing & Technology Division, Department of Horticulture, O.S.U. and O.A.E.S.

The quality of the final product is one of the paramount factors which determine the success of a canning operation. Many factors contribute to quality. In this study we were concerned with those factors related to drained weight of canned tomatoes: fill weight, variety, NaCl salt tablets vs. NaCl-$CaCl_2$ salt tablets, method of producing a vacuum, and harvest date of the tomatoes. The purpose of the study was to establish the relationship between fill weight and drained weight so that tomatoes could be packed at specified fill weights to yield predetermined drained weights of Grade A, Grade B, and Grade C. By establishing this relationship, a processor packing tomatoes of Grade B quality in terms of wholeness, color, and absence of defects could calculate the fill weight required to yield a Grade B quality drained weight, etc. Thus, he could eliminate costly overfill and increase the efficiency and profits of his operation.

During the 1960 canning season, fourteen varieties of tomatoes were individually hand-packed in #303 cans at five fill weights: 9.0 - 9.5 ounces, 10.0 - 10.5 ounces, 11.0 - 11.5 ounces, 12.0 - 12.5 ounces, and a solid pack in which each container was packed as full as possible without crushing the fruit. A 30 grain salt tablet (21 grains NaCl and 9 grains $CaCl_2$ or 30 grains NaCl) and juice were added. One-half of the cans were conveyed through the exhaust box prior to closing while the other half were closed by steam flow closure. Approximately four months later, the tomatoes were graded according to the procedures set forth in the U. S. Standards for Grades of Canned Tomatoes.

Analysis of variance in drained weights showed that the influence of variety and fill weight was highly significant. The tomatoes canned with NaCl-$CaCl_2$ salt tablets gave significantly higher drained weights than the drained weights of the tomatoes canned with NaCl salt tablets added. The method of producing the vacuum in the cans had no significant influence on drained weight while the influence of harvest date varied, dependent greatly upon variety.

Since fill weight is highly significant relative to drained weight, the relationship between these two factors, if known, would enable one to calculate a specific fill weight required to attain a predetermined drained weight when the can is cut. From the drained weight data collected during the 1960 canning season, we determined the percentage decrease in weight or the percentage that the drained weight is of the fill weight. The results were further analyzed statistically to determine a range which would include 83.4% of the cans (5 out of 6). From these two figures, fill weights were calculated for the 1961 canning season. Using Glamour as an example; the fill weights were calculated in the following manner:

1. The average drained weight was determined for each fill weight and the percentage drained weight relative to fill weight was calculated

Fill wt. (oz.)	Dr. wt. (oz.)	% of fill wt.
9.0- 9.5	8.47	91.5
10.0-10.5	9.35	90.3
11.0-11.5	10.28	90.5
12.0-12.5	10.79	88.1

2. A range, including 83.4% of all cans, was established statistically at 0.4 ounces at the 12.0-12.5 ounce fill weight and 0.2 ounces at the 9.0-9.5 ounce fill weight.

3. The desired cut-out drained weight for the 1961 season was chosen: Grade A = 11.9 ± 0.4 oz., Grade B = 11.4 ± 0.4 ounces and Grade C = 8.5 ± 0.2 oz.

4. The fill weights were then calculated as follows: 11.9 x 100/88.1 = 13.5; 10.4 x 100/90.5 = 11.5; 8.7 x 100/91.5 = 9.5.

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The fill weight ranges were then established at 13.25 - 13.75 ounces for Grade A, 11.25 - 11.75 ounces for Grade B, and 9.25 - 9.75 ounces for Grade C.

Using the above procedure, fill weights were calculated for eight varieties processed during the 1961 season in which we attempted to attain a drained weight of Grade A, Grade B, and Grade C quality for each variety. The following table is a summary of the results.

Drained Weight Averages of Canned Tomatoes by Grade and Variety for 1961

VARIETY	GRADE A DR. WT. (oz.)[1]	GRADE B DR. WT. (oz.)[2]	GRADE C DR. WT. (oz.)[3]
Glamour	12.28	10.66	9.28
Rutgers	12.61	11.42	9.33
Heinz 1370	12.53	10.94	9.69
KC 146	12.31	10.94	8.97
Fireball	12.42	10.17	9.17
C 52	12.33	10.42	8.50
Hoytville #6	12.08	10.72	9.19
Hotset	11.58	10.50	8.50

1 - Grade A quality requires a dr. wt. of 10.0 oz. or more.
2 - Grade B quality requires a dr. wt. of 9.75 oz. up to 11.0 oz.
3 - Grade C quality requires a dr. wt. of 8.5 oz. up to 9.75 oz.

All drained weights fell into their predetermined Grade range except for the Grade B drained weight for Rutgers which was in the Grade A range. However, all of the drained weights, except for Hotset, were about 0.5 ounces higher than required for a middle Grade A score, or 19 points.

These data indicate that tomatoes, when processed under the conditions used herein, can be filled at specific fill weights and be expected to yeild predetermined drained weights of either Grade A, Grade B, or Grade C quality. Thus, when Grade A, Grade B, or Grade C quality tomatoes are being packed, less expensive juice can be substituted for whole tomatoes yielding a less costly, more uniform quality pack in addition to elimination the overfill problem than when each container is packed full without regards to fill weight.

CALCIUM IN CANNED TOMATOES

by John Hal Johnson, Richard Leiss, Wade Schulte, and
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In 1940 Kertesz et al reported research on the use of calcium salts as a firming agent in canned whole tomatoes. In the same year, the Food and Drug Administration in the "standard of identity" for whole canned tomatoes required that the finished product not exceed 0.026% calcium.

Calcium chloride was added at five different levels to peeled tomatoes before processing. After several months storage, these samples and three additional samples, two commercial and a third packed at Ohio State University during the regular canning season, were graded and the liquid and pulp were analyzed for calcium. All samples were 50-60 grams in size and were portions of homogenous samples of the liquid or the homogenized pulp. The sample was dried in an oven, then ashed in a furnace at 525°C.[2] The ash was extracted with dilute hydrochloric acid, filtered and analyzed for calcium according to NCA procedure 20-19.[1]

SAMPLE NO.*	% CALCIUM ADDED	% CALCIUM FOUND	% DIFFERENCE OF LIQUID TO PULP
1-L	0.000	0.0037	0.0037
1-P	0.000	0.0074	
2-L	0.0085	0.0107	0.0037
2-P	0.0085	0.0144	
3-L	0.017	0.0186	0.0066
3-P	0.017	0.0252	
4-L	0.0255	0.0268	0.0067
4-P	0.0255	0.0335	
5-L	0.034	0.0325	0.0064
5-P	0.034	0.0399	
6-L	0.026	0.0511	0.0029
6-P	0.026	0.0540	
7-L	0.026	0.0379	0.0033
7-P	0.026	0.0411	
8-L	0.000	0.0036	0.0012
8-P	0.000	0.0048	

* L - liquid, P - pulp

In 1944, Beeson et al[3] found that tomato plants grown in nutrient solution containing an increasing amount of calcium bore fruit containing an increasing amount of calcium.

CALCIUM PER LITER OF NUTRIENT SOLUTION	CALCIUM IN TOMATO FRUIT
0.0056 gms	0.0057
0.0114	0.0070
0.0170	0.0083
0.0226	0.0104
0.0284	0.0109
0.0340	0.0142
0.0396	0.0147

In a study reported in 1952, Hamson[4] found that firm tomato varieties accumulate more calcium than soft or intermediate firm tomato varieties. All varieties increase in calcium as more is available to the plants.

From the literature and our data, it is apparent that the amount of calcium in the canned tomato is dependent on three factors: (1) the variety, (2) the amount of calcium available in the soil, (3) the amount of calcium added during processing.

References:

1. A Laboratory Manual for the Canning Industry, NCA (1954).

2. Official Methods of Analysis of the Association of Official Agricultural Chemists, 8th Edition, (1955) p.535.

3. Beeson, K. C., et al. "Ionic Absorption by Tomato Plants as Correlated with Variation in Composition of the Nutrient Medium", Plant Physiology 19, 258, (1944).

4. Hamson, A. R. "Factors which Condition Firmness in Tomatoes", Food Research 17, 4, (1952).

5. Kertesz, Z. I., et al. "The Use of Calcium in the Commercial Canning of Whole Tomatoes", Technical Bulletin No. 252, New York Agricultural Experiment Station, Geneva, N. Y., 1940.

POTASSIUM SORBATE FOR THE PRESERVATION OF FRESH FRUIT JUICES

by D. Robert Davis, Fruit and Vegetable Processing & Technology Division, Department of Horticulture, O.A.E.S.

Several years ago a new preservative was introduced to the food industry. This chemical, sorbic acid, was found to be a very effective antimycotic in baked goods, cheeses and cheese products, dried fruits, fish, and non-carbonated (still) beverages and fruit juices. Sorbic acid and its sodium and potassium salts are included in the U. S. Food and Drug Administration list of chemicals "generally recognized as safe", published under the 1958 food additives admendment. Since both sorbic acid and sodium sorbate are relatively insoluble, its importance in the beverage industry was not realized until potassium sorbate, which is highly soluble, was developed two years ago. As a result it has completely replaced sodium benzoate in this field. Not only is it a more effective and eff icient antimycotic agent (0.025 to 0.05% potassium sorbate is as effective as 0.1% sodium benzoate), it has no adverse effect on the flavor as does the sodium benzoate.

As long as the pH of the beverage is below 6.5, the most important factor affecting the effectiveness of potassium sorbate is the temperature. At room temperature the shelf life of a beverage is increased by about 1 week, whereas at 35°F. the shelf life is increased by more than 6 months.

Recent tests in our laboratories have shown that when used in apple cider, potassium sorbate will change the flavor of the cider during storage as shown in Table I. This change in flavor apparently is dependent upon the apple variety from which the cider was made. Further, this flavor change appears to be more pronounced after 3 months storage than after storage periods of 4, 5, or 6 months.

TABLE I - The Effect of Apple Variety on the Flavor Change in Fresh Cider Containing 0.05% Potassium Sorbate at 35°F. Storage.

	PERCENT FLAVOR CHANGE				
VARIETY	3 MO.	4 MO.	5 MO.	6 MO.	AVERAGE
Stayman Winesap	5.6	2.8	0	0	2.1
Ruby	-6.8	-2.7	1.4	2.7	-1.4
Franklin	-7.1	4.3	4.3	-8.6	-1.8
Melrose	-6.9	-4.2	5.6	2.8	-2.7
Northern Spy	-11.7	-5.2	-11.7	-3.9	-8.1
Red Delicious	-13.5	-8.1	-10.8	-4.1	-9.1
Turley	-13.7	-8.2	-9.6	-9.6	-10.3
Rome Beauty	-19.5	-11.7	-5.2	-6.5	-10.7
AVERAGE	-9.2	-5.2	-3.3	-3.4	

The present recommendation for the use of potassium sorbate in cider is 0.05% by weight. An increase in potassium sorbate above this level will not increase its effectiveness as a preservative. This season potassium sorbate was added to fresh, enzyme clarified, filtered cider at concentrations of 0.05 and 0.1% by weight. Triangular taste tests determined immediately aft er the addition showed that although there was a slight flavor difference no preference was indicated for one treatment over the other.

The results of a triangular taste panel on the samples after 1 months storage are shown in Table II.

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TABLE II - Results of Triangular Taste Panel Tests on Fresh Cider After 1-Months Storage at 35°F.

TREATMENT	N	No. CORRECT	PREFERENCE
No treatment vs. 0.05% potassium sorbate	7	5*	Neither
no treatment vs. 0.1% potassium sorbate	7	7***	0.1%
0.05% vs. 0.1% potassium sorbate	7	3	

* P = .05; *** P = .001

The cider containing 0.1% potassium sorbate was preferred over the untreated samples, yet the panel could distinguish no difference between the 0.1% and the 0.05% potassium sorbate samples. These tests will be continued over several months to determine whether this difference in concentration will have an effect on the flavor of the cider as the storage time is increased.

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WATER HANDLING AND HOLDING STUDIES OF TOMATOES
I PILOT PLANT PHASE

by Richard Leiss and W. A. Gould, Fruit and
Vegetable Processing & Technology Division,
Department of Horticulture, O.S.U. and O.A.E.S.

Tomatoes of the following varieties,

1. Glamour
2. KC 146
3. Heinz 1370
4. ES 24 (1961 only)

and of the following qualities,

1. Quality I - 90% red with no cracks or defects
2. Quality II - 75% red with no cracks or defects
3. Quality III - 90% red with every tomato cracked (one inch or more)

were held in different solutions,

1. Water
2. Water with chlorine - 25 ppm
3. Water with Klenzade Tomato Washing Compound No. 1 - 83 ppm
4. Water with Sorbic acid - 100 ppm

for two periods of time, at (1) 12 hours and (2) 24 hours, and for three storage temperatures, (1) 70°F., (2) 55°F., and (3) 45°F., to study the effect of these variables on canned, peeled tomato quality.

The tomatoes held under the conditions listed above were processed at the O.S.U. Fruit and Vegetable Processing and Technology Division Pilot Plant using commercially acceptable practices. After storage periods of six months the canned samples were evaluated using U.S.D.A. Standards for Grades for Canned Tomatoes. (Drained weight, wholeness, color, and absence of defects.) In addition the pH and total acidity of the samples were determined. This study was conducted during the past two years (1960-1961).

Following the evaluation of the above processed samples representing the 288 variables present, the following preliminary conclusions can be made.

1. Drained weight of canned tomatoes appears to be the best grade factor for determining the effects of different times, temperatures, and treatments in holding tomatoes prior to processing.

2. In comparing varieties, the canned samples from the variety Heinz 1370 were significantly better than those samples from the varieties Glamour and KC 146. From the 1961 data, samples from the variety ES 24 were approximately equal to the samples from the Heinz 1370 after the various holding experiments.

3. Under the conditions of this study, the quality (drained weight) of the finished product was directly related to the raw product qualities; although, no consistent differences were noted when comparing all three varieties. In other words, within a variety, the quality of the raw stock was a most significant factor. (See summary table below.)

4. There was no effect on canned tomato quality due to the various chemicals that were added to the water tanks for the holding studies; however, visual examination of the raw product after given periods of holding times indicated that tomatoes in the tanks containing the tomato washing compound were considerable cleaner than those from the straight water tanks. No noticeable effects were noted for sorbic acid or chlorine treated lots.

5. The data indicated that canned tomato quality (drained weight, in particular) was reduced by holding the tomatoes in the various water and water solutions at the

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higher temperature (70°F.) when compared to the lower holding temperatures (55°F. and 45°F.). However, this difference was not true for all varieties at all levels of quality, as when compared to zero hours for tomatoes not held in water (check samples), the samples of the Heinz 1370 variety had a greater drained weight after holding for both the twelve and 24 hours and, consequently, were of higher quality after the water holding periods. This can be partially attributed to the fact that fruits from this variety were smaller (106 per 25 pounds) compared to fruits of the KC 146 (83 per 25 pounds) variety.

It should be emphasized that fruit used in this phase of the study were all hand harvested, hand sorted and graded, and no over-mature fruits were used. No appreciable breakdown of the fruit occurred during the conditions of this phase of the water holding studies. It could be concluded, that tomatoes from these three varieties, at these levels of raw product quality, and for these times and temperatures of holding tomatoes in water and water solutions, that no detrimental effects or lowering of finished product grade was noted on the resultant canned, peeled tomatoes. The effects of mechanical harvesting other varieties and other levels of qualities, and so forth, would have on water holding must be discerned before this practice can be recommended for general commercial use. However, from all evidence deduced in our pilot plant studies, it does appear to offer the processor a new method for handling and holding tomatoes prior to canning. It should be emphasized that Drosophila Fly activity was practically absent and mold growth was of no consequence even after 48 hours, particularly in the water-chemical solution lots. Spore counts were determined on all of the 1961 lots, but the results from these studies are so erratic that no statement can be made on this phase until all the data have been further substantiated and statistically interpreted.

SUMMARY TABLE SHOWING EFFECT OF HOLDING TIME AND TEMPERATURE ON DRAINED WEIGHT OF CANNED TOMATOES BY QUALITIES (all data in ounces).

			TIME (hours) AND TEMPERATURE					
			70°F.		55°F.		45°F.	
VARIETY	QUALITY	CONTROL*	12	24	12	24	12	24
Glamour	I	10.83	9.92	10.15	10.35	10.42	10.4	10.75
	II		10.57	10.37	10.42	10.22	10.37	10.67
	III		10.32	9.75	10.22	10.25	10.12	10.25
KC 146	I	10.65	11.0	10.3	10.72	10.6	11.02	10.9
	II		10.47	10.27	10.55	10.57	11.15	10.67
	III		10.4	10.1	10.52	10.29	10.57	10.9
Heinz 1370	I	10.41	11.22	11.35	11.22	11.4	11.65	11.42
	II		11.0	11.2	10.8	11.07	11.05	11.15
	III		11.05	11.15	11.15	11.2	11.17	10.7

* Control samples were not held prior to canning and represented No. I level of quality only.

LSD at .01 for Glamour variety - time and temperature treatments = .30; quality = NS
LSD at .01 for KC 146 variety - time and temperature treatments = .25; quality = .47
LSD at .01 for Heinz 1370 variety - time and temperature treatments = NS; quality = .79

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WATER HANDLING AND HOLDING STUDIES OF TOMATOES
II COMMERCIAL PHASE

by Richard Leiss, W. A. Gould and Winston Bash, Fruit and Vegetable Processing & Technology Division, Department of Horticulture, O.S.U. and O.A.E.S.

On September 11, 1961, in Ottawa County, Ohio, a study was undertaken to evaluate the quality of mechanically harvested (FMC and Hume Harvesters) tomatoes while being held in tanks (approximately 700 pounds of tomatoes and 700 pounds of water) containing water or water and detergent (Klenzade Tomato Washing Compound No. 1 - .3% solution). No attempt was made to distinguish quality differences between mechanically harvested and hand picked fruit.

Relatively equal weights of three tomato varieties (C-52, ES 24, and Red Top) were added to the metal tanks containing either plain water or the water and detergent solution. Evaluation was undertaken at three specific times: (1) immediately after the tomatoes were placed in the solution, (2) after holding the tomatoes for 24 hours in the water and the water-detergent solution, and (3) after holding the tomatoes for 48 hours in the water or the water-detergent solution. Spore counts of the water and the water-detergent solution were taken directly from the tanks and the quality of the tomatoes were determined with the aid of photographs (color slides) and visual examination.

From this study the following conclusions are made:

1. Tanks containing detergent solution had zero or near zero spore counts immediately after placing the tomatoes in these tanks. Fruit placed in the tanks containing water had significantly higher spore counts.

2. After 24 hours of holding the tomatoes in the tanks, the average spore counts were approximately equal for both water and the water-detergent tanks. However, spore counts did vary according to the variety of tomato, due primarily to the quality of the raw stock. (C-52 = 93/ml., ES 24 = 210/ml., and Red Top = 80/ml.)

3. Average spore counts were higher in the water-detergent tanks when compared to those in the water tanks after the 48 hour sampling period:
   C-52 = Detergent - 120/ml., water - 10/ml.
   ES 24 = Detergent - 540/ml., water - 185/ml.
   Red Top = Detergent - 170/ml., water - 120/ml.

4. When tomatoes were held in water, mature fruit deteriorated more rapidly and to a greater extent than did less mature fruit.

5. The detergent solution retarded white mold formation to a greater extent than did the plain water.

6. Tomatoes held in detergent solution were visibly brighter in color and more firm than those held in water.

No comparison is made between the harvesters because: (1) they were clean upon entry into the field; (2) they were run for only a short period of time; (3) the soil was dry; and (4) there were no records made of fruit left in the field or damaged fruit in the tanks due to the harvester. Both haversters performed well and under these conditions seem to do a very satisfactory job.

From this study and our pilot plant studies, it would appear that tomatoes can be taken directly from the harvester and dumped directly into water tanks containing .3% detergent and held up to 24 hours without any appreciable change. Shorter holding times would be recommended, however. Tomatoes held in detergent solutions for short periods of time have lower spore counts, better color, and less mold growth. At no time, including the 48 hour period for holding the tomatoes in water, was there any evidence of Drosophila fruit fly activity.

LYE PEELING AND ACIDIFICATION OF CANNED TOMATOES

by W. A. Schulte and W. A. Gould, Fruit and Vegetable Processing & Technology Division, Department of Horticulture, O.S.U. and O.A.E.S.

With the advent of lye peeling of tomatoes, this study was undertaken to determine the influence of lye peeling and the probable effect of acidification upon pH, total acidity, and quality of canned tomatoes.

Twelve varieties of tomatoes grown on the Horticultural Farm at the Ohio State University were used in this study. Only those tomatoes which graded No. 1 were processed. The following peeling procedures were used, steam scalding being the standard for the lye peeling:

1. 212°F. steam scald for 45 seconds @ full steam capacity.
2. 180° - 190°F. agitated lye solution dip for 25 seconds followed by a 45 second holding interval (lye reaction time) prior to washing to remove the lye.
3. 80°F. agitated lye solution dip for 20 seconds immediately followed by a 45 second steam scald @ 212°F. and 30% of steam capacity prior to washing to remove the lye.

The concentration of both lye solutions was controlled to 18 ± 2% by weight. Commercially acceptable practices were followed in all other unit operations. To one-half of the lots, 1.0 gram (0.2% by weight) of citric acid was added.

The following tables summarize the results:

TABLE I

pH by Acidification and Peel Method[1]

Treatment	Steam	Hot Lye-Dip	Cold Lye-Dip
Non-acidified	4.27	4.29	4.27
Acidified	4.02	4.02	4.03

1 Average values for 12 varieties

TABLE II

Percentage Citric Acid by Acidification and Peel Method[1]

Treatment	Steam	Hot Lye-Dip	Cold Lye-Dip
Non-acidified	0.41	0.40	0.42
Acidified	0.55	0.55	0.55

1 Average values for 12 varieties

The use of a lye solution to facilitate peeling at either 80°F. or 180° - 190°F. as contrasted to the steam scald control had no effect on either the pH or the total acidity of the non-acidified or acidified canned tomatoes as shown in Table I and Table II respectively. However, the addition of one gram of citric acid lowered the pH for both of the lye peeled lots and the steam peeled lots approximately 0.25 pH units below the non-acidified controls, while the percentage citric acid increased approximately 0.14% over the non-acidified controls.

TABLE III

Attributes of Quality for Canned Tomatoes by Acidification and Peeling Method[1]

ATTRIBUTES OF QUALITY	STEAM		HOT LYE DIP		COLD LYE DIP	
	NON-ACIDIFIED	ACIDIFIED	NON-ACIDIFIED	ACIDIFIED	NON-ACIDIFIED	ACIDIFIED
dr. wt. (oz.)	12.28	12.24	12.27	12.30	12.36	12.27
dr. wt. (pts.)	19.8	20.0	19.9	19.9	20.0	19.8
whln.	17.7	17.4	19.3	17.6	17.5	17.1
color	28.1	28.3	27.7	28.1	27.8	29.9
abs. of def.	23.6	28.7	28.4	28.9	28.7	28.8
Total Score	94.2	94.4	93.3	94.5	94.0	93.4
Grade	A	A	A	A	A	A

1 Average values for 12 varieties.

Table III summarizes the data relating lye peeling and acidification to the attributes of quality of the processed tomatoes. It is evident that very little difference if any exists due to acidification. Also, little difference is noted due to peeling methods.

On the basis of the procedures followed in this study, the use of lye as a method of peeling will not alter quality, pH, and/or total acidity of the processed products. However, acidification with citric acid (0.2% by weight) decreased the pH by 0.25 units and increased the total acidity 0.14% (when expressed as citric acid) in the canned product. It should be noted that the Standard of Identity does not permit the addition of citric acid at the present time.

EFFICIENCY AND QUALITY OF CANNED TOMATOES INVOLVED IN FOUR METHODS OF PEELING

by Wade Schulte and W. A. Gould, Fruit and Vegetable Processing & Technology Division, Department of Horticulture, O.S.U. and O.A.E.S.

Peeling is a high cost unit operation in the tomato processing business. This study involves a determination of the efficiency of four methods of peeling tomatoes recorded in terms of peel time and amount of peel removed. Quality of the canned product was also analyzed.

The tomatoes were peeled in the following manner:

1 - Steam scald, 45 seconds exposure to steam (212°F.),

2 - Infra-red rays, 22 second exposure @ 1500°F.,

3 - Hot lye dip, 25 second agitated dip @ 180° - 190°F. followed by a 45 second reaction period prior to washing to remove the lye,

4 - Cold lye dip, 20 second agitated dip @ 80°F. followed directly by 45 second steam scald just prior to washing for lye removal.

The lye concentration was controlled to 18 - 20% by weight. The peel times were recorded and the amount of peel removed was weighed directly following each lot. All tomatoes were processed in 30 pound lots, except for the infra-red lots which were 15 pounds each. The data have been converted to represent pounds of tomatoes peeled per hour and pounds of peel removed per 100 pounds of fruit. Following approximately a three month storage period, the samples were graded according to the procedures set forth by the U. S. Standards for Grades of Canned Tomatoes. The following tables summarize the results:

TABLE I - Pounds of Tomatoes Peeled per Hour and Pounds of Peel Removed by Peeling Method[1]

PEELING METHOD	POUNDS PEELED PER HOUR	POUNDS OF PEEL REMOVED PER 100# OF FRUIT
Steam	252	6.89
Infra-red	297	4.69
Hot lye dip	281	3.86
Cold lye dip	300	5.79

1 - Averages taken from 12 varieties.

Peeling the steam scalded tomatoes was the slowest of the four methods and resulted in the greatest amount of peel removed. Peeling those dipped in the cold lye solution was the fastest being followed very closely by the infra-red lots. However, the infra-red lots had lower peel loss than did the cold lye dip lots; and, although it was not the lowest, it would have to be judged the most efficient since the hot lye dip had a lower peeling rate. The lower hot lye dip peeling rate was probably caused by a lack of sufficient lye action to loosen the skin completely thus leaving tight spots in the fruit which were difficult to remove and in some cases was probably missed as will be evidenced later in this report.

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TABLE II - Attributes of Quality by Peeling Method[1]

METHOD OF PEELING	DR. WT. OUNCES	DR. WT. POINTS	WHOLENESS	COLOR	ABS. OF DEFECTS	TOTAL SCORE	GRADE
Steam	12.28	19.8	17.7	28.1	28.6	94.2	A
Infra-red	12.36	19.9	18.5	28.1	29.1	95.6	A
Hot lye dip	12.27	19.6	17.2	27.7	25.0*	89.0	B
Cold lye dip	12.36	20.0	17.5	27.8	27.4	92.7	A

1 - Grades represent averages of twelve varieties.
* - Indicates limiting rule.

For the drained weight and color attributes, very little difference in quality exists that is assignable to peeling methods. The infra-red lots scored slightly higher in wholeness than either of the lye peeled lots or the steam scalded lots. However, when considering the absence of defects attribute, the infra-red lots were graded the highest followed closely by the steam scalded lots. The cold lye dip lots were somewhat lower than the steam scalded lots but still in the Grade A range. However, the hot lye dip lots were scored Grade B for absence of defects which was serious enough to lower the total score to Grade B. The differences in the absence of defects scores are assignable to peel not removed from the fruit and consequently included in the processed product. For the infra-red lots, difficulty was experienced with small, black, charred pieces of peel which were clinging to the tomato even though they were loose. Much time was involved in trying to remove them in the peeling operation. All were not removed prior to filling and closing the containers. However, upon examination of the canned tomatoes after storage, little evidence of these pieces of peel existed. The steam scalded lots showed very little peel upon examination. The cold lye lots exhibited more peel than the steam scalded lots but less than the hot lye dip lots. The main quality difference in the four peeling methods was the amount of peel present in the processed product. There is some evidence in the literature that the use of a wetting agent would give a better lye reaction and thus, possibly solve this problem.

Further contemplated studies in this area involve:

1. Wetting agents in conjunction with lye peeling.

2. Adaption of the infra-red peeling unit to a roller conveyor.

3. The use of various holding times prior to steam scald for the cold lye dip method.

4. Steam scalding in conjunction with holding times for the hot lye dip method.

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THE HEAT PROCESSING OF FOODS IN FLEXIBLE FILMS

By
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I. Films

Up to the present time, metals and glass were the only packaging materials used for heat processing of foods. Flexible materials were limited to containers for dried, frozen, or refrigerated products; however, flexibles have been developed that will withstand the temperatures necessary for sterilization of food products.

Flexible packaging materials offer many advantages over both glass and tin containers. These are: lower shipping cost of containers and filled packages; lower materials cost; less inventory storage space; portion control; consumer preparation of several products in the same heating vessel; possible reduction of retort cycle; and little or no container disposal problem.

To be successfully retorted, a packaging material must have the following properties:

(1) Oxygen permeability less than 1 cc./100 sq. in./24 hours/1 atmosphere differential.
(2) Moisture vapor transmission less than 0.05 grams/100 sq. in./24 hours.
(3) Resistance to temperatures over 250° F. and below 32° F.
(4) Low hydrophylic properties.
(5) Economical.
(6) Heat sealable.
(7) Suitable for food usage (FDA approved).
(8) Resistance to penetration of fat, oil, and color components of food.
(9) Resistance to stress corrosion and pinhole fatigue.
(10) No tendency to impart objectionable odor or flavor to foods.
(11) Consumer appeal.
(12) Can be handled on automatic fabrication and filling equipment.
(13) Good aging properties--storage, a minimum of six months to one year.
(14) Can be printed for product identification and consumer appeal.

At present, there is no single film which meets all of these requirements. Several materials fulfill most of the requirements. These include: polyethylene terphthalate (polyester), polypropylenes, polyvinyl and aluminum foil. When two or more of these materials were combined or laminated together, a more nearly ideal package resulted. The combinations evaluated in this study are shown in Table 1.

Table 1 - Flexible Materials Evaluated for Retort Processing

Continental Can Co. Designations	Film Combination
8346-1	Polyester-intermediate density polyethylene
8346-2	Polyester-polypropylene
8346-3	Polyester-foil-vinyl
8546-1	Polyester-foil-vinyl
8546-2	Polyester-foil-vinyl
8546-3	Polyester-foil-polypropylene
8546-4	Polyester-polypropylene

It should be noted that although many of the film names are the same, different adhesives and improved films were used. Only films 8346-3 and 8546-1 were the same since the 8546 films were made from improved materials based on the performance of the 8346 films.

The pouches were evaluated for ability to withstand retorting, appearance after retorting, and durability during storage. The primary concern was the ability of the film to withstand retorting for a sufficient period to produce sterility in the various commodities.

Several factors influenced the successful retorting of the pouches: Low over-riding air pressure, sealer damage, or product in the seal area caused a low recovery. Of these, low over-riding air pressure was most serious since recovery was reduced to only five to fourteen percent when this occurred. For this reason, an over-riding air pressure of 25-27 p.s.i. was recommended during both the heating and cooling cycles.

The appearance of the pouches after retorting is summarized in Table 2.

Table 2 - Physical Condition of the Pouch Materials after Retorting

Film	Condition	Remarks
8346-1	Good	230° F. temperature limit
8346-2	Delaminated	Amount of delamination increased with process time
8346-3 and 8546-1	Slightly shop-worn	Variation among pouches
8546-2	Extremely shop-worn	Pinholing evident
8546-3	Excellent	Stiffer material
8546-4	Excellent	Clear pouches

From Table 2 it can be seen that for retort processing at 250° F., only films 8546-3 and 8546-4 were satisfactory.

Producing a commercially sterile package is of no value if the finished product cannot be marketed through normal channels. Thus, shipping tests were also made on the packages after retorting. Film 8546-4 showed no breakdown, while 6% of the 8546-3 pouches were affected. Films 8546-1 and 8546-2 had failures of 25 and 31 percent respectively.

When all of these results were compared, the data indicated that film 8546-4 was best suited for retort processing. Work is continuing on the development of new materials and adhesives; however, these studies have shown that retort processing of foods in flexible films is feasible and will provide advantages to the processor, merchant, and consumer.

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THE HEAT PROCESSING OF FOODS IN FLEXIBLE FILMS

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II. Retorting

Since the primary porpose of this study was to produce a product in flexible films which could be stored at room temperature, the operation of the retort was of most importance. During the initial phase of this study, a high percent of pouch failures resulted from the retort procedures used for the processing in tin cans. These failures were probably due to softening of the films at high temperatures (230°-250°F.) with a resultant decrease in seal strength and to an increase in the internal pressure of the pouches. In order to overcome these causes, an over-riding air pressure was maintained in both the heating and cooling cycle.

It was found that an over-riding air pressure of 25-27 p.s.i. was required to produce satisfactory results. As the air pressure was reduced from this level, the percent failures increased. Due to the temperature lag of the contents during cooling, the over-riding pressure could not be reduced until the cooling cycle ended.

After overcoming the initial cause of pouch failure it was found that many of the pouches were wrinkled and "shop-worn" in appearance after retorting. This was particularly noticeable in film laminents containing aluminum foil and probably led to pinholing and to more serious delamination of the films. The condition was attributed to variations in pressure caused by surging in the retort by the entrance of steam or air. This was further substantiated by the data on the control charts. This condition was corrected by increasing the sensitivity of the pressure controls. Retort processing of products in flexible films is similar to that for products in glass containers, with the exception that the degree of control must be more precise for the flexible films.

THE HEAT PROCESSING OF FOODS IN FLEXIBLE FILMS

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III. Heat Penetration

Foods heat-processed in flexible film pouches present an entirely new concept in heat processing, retort operation and heat conduction. Due to the flexibility of the pouches, the rectangular shape ($5\frac{1}{2}$ x $8\frac{1}{4}$ in.) and the different materials used in the films, it was necessary to conduct heat penetration tests to determine the heating patterns of these pouches.

Cream style corn was prepared under commercially acceptable conditions and filled into specially prepared pouches which were fitted with a thermo-couple probe. Entry was made through the pouch wall by using a special nut and washer screw clamp. Before filling the pouch, the thermo-couple wire was inserted through the special clamp and the wire twisted into a spiral coil with the end of the wire probe in the center of the coil. This aided in holding the probe close to the geometric center of the pouch. The pouches were sealed and placed in a retort rack designed to control physical distortion of the pouches during processing. The thermo-couple leads were attached to a Foxboro E.M.F. Dynalog Multirecord Temperature Recorder to measure and record the temperature changes within the pouches during the retorting cycle. Tin cans fitted with thermo-couples and filled with cream style corn were processed at the same time as the flexible pouches to serve as controls and reference samples.

In making these heat penetration tests, three different flexible films were used: film 8346-1, polyester-intermediate polyethylene; film 8346-2, polyester polypropylene; and 8346-3, polyester-foil-vinyl. The first two films were clear materials, and the third was opaque with one of the laminates being aluminum foil.

The heating curve illustrated the heating pattern of the three flexible films as compared to the tin can. It was quite evident that the contents of the tin can lagged behind the three films during the heating phase of the retort cycle; however, the corn in the tin can stayed at the high temperature longer during the cooling cycle. This difference in heating and cooling patterns was caused by the different shapes of the containers. Even though both containers held the same amount of material, the rectangular shape of the pouch held the corn in such a way as to have only one inch thickness at the thickest point. This was compared to the cylindrical shape of the tin can with a diameter of three and 3/16 inches. With this in mind, it was easy to see why the center temperature of the pouch would be reached faster than that of the tin can.

The data obtained from the heat penetration tests were calculated as F_o values (F_o value is the equivalent value of the process in terms of minutes at 250° F. when no time is involved in heating to 250° F. or cooling to sub-lethal temperature.) The table on the following page gives the F_o values for the three flexible films and the tin can. The F_o values for the films were considerably higher than those for the tin can, thus indicating a substantial reduction in process would be possible for the flexible films.

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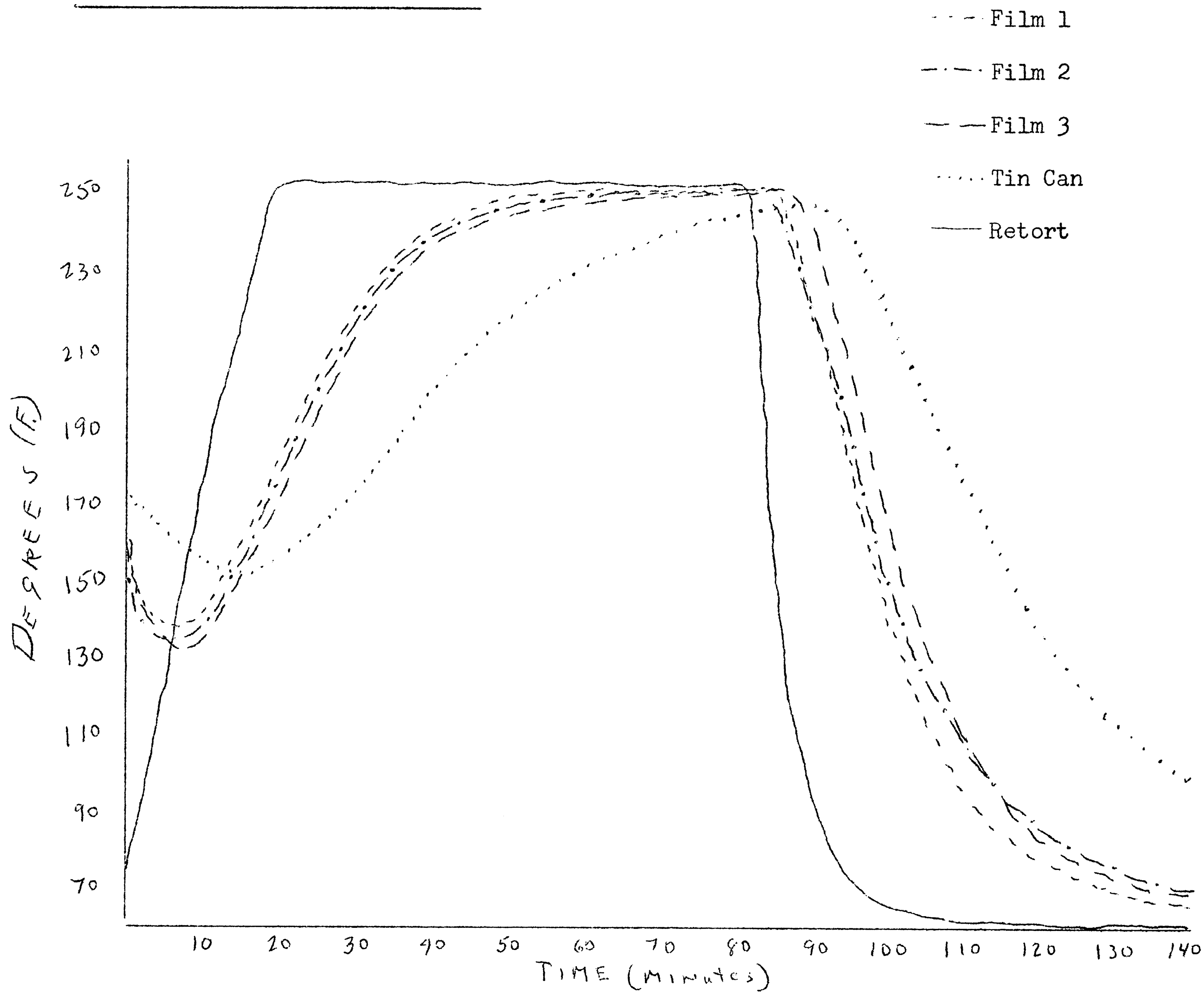
F_o Values for the Three Flexible Films and the Tin Can (5 Replicates) Calculated from Processing Cycles of 250° F. for 65 Minutes.

Film	Test 1	Test 2	Test 3	Test 4	Test 5	Average	Range
	F_o Values						
8346-1	39.87	49.99	58.20	48.50	36.61	46.63	21.59
8346-2	21.99	33.20	46.68	34.89	45.49	36.45	24.69
8346-3	51.57	31.95	47.87	43.13	29.82	40.86	21.75
Tin Can	14.48	31.10	19.87	14.88	22.42	20.55	16.62

CHART I - HEAT PENETRATION DATA



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THE HEAT PROCESSING OF FOODS IN FLEXIBLE FILMS

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IV. Bacteriological Studies

Throughout the experimental work conducted on heat processed flexible film pouches, bacteriological studies were used to determine the efficiency of the heat process and the effectiveness of the flexible pouches as a protective container. In the initial studies on cream style corn and green beans, E. coli was inoculated into test pouches to determine the effectiveness of the processing cycle. Each time samples were opened for quality evaluations, aliquots were taken and plated to determine if there was any bacterial growth. Due to the low heat resistance of E. coli as a test organism, additional bacteriological studies were made, using Mesophilic Flat Sour 5230-37 and heat-resistant putrefactive anaerobe 3679-42. These organisms were obtained from the Metal Division, Research and Development Department of the Continental Can Company.

Procedures: After filling, the pouches were inoculated under aseptic conditions with one ml. aliquots containing approximately one million spores of the appropriate organism. The following inoculation schedule was used:

10 pouches were inoculated with 5230-37
10 pouches were inoculated with 3679-42
20 pouches were not inoculated and were used as controls

Immediately after inoculation the pouches were sealed and placed in the retort. Process times were varied at 250° F., depending upon the commodities (Table I).

Table I - Process Times at 250° F. for Various Commodities*

Commodity	Time (minutes) Recommended**	Additional Processes
Snap Beans	12	10
Cream Style Corn	65	49, 56
Potatoes (diced)	23	8, 11, 14, 17, 20, 26

* Retort was operated under 25-27 p.s.i. air pressure during heating and cooling cycles.
** NCA recommendations for a No. 303 tin can.

After cooling, the pouches inoculated with 5230-37 were placed in a 98° F. incubator for 30 days. The pouches containing 3679-42 were stored at 70° F., due to lack of space. One-half of control pouches were opened after 30 days, and the other half at 90 days.

An indicator, brom cresol purple, was used to determine whether growth of 5230-37 organisms had taken place. A change from purple to yellow indicated growth. In the case of 3679-42 organisms, the formation of gas and putrid odor indicated growth.

Results: The retort processing of low-acid vegetables in flexible films was successful. This was proven by the fact that none of the pouches inoculated with putrefactive anaerobe 3679-42 and processed at the recommended times at 250° F. developed a putrefactive odor. The successful destruction of these spores by heat means that an adequate sterilization process with respect to *Clostridium botulinum* could be obtained.

The data further indicated that the process could be reduced from the recommended time. The shortest process time which killed the spores of this organism as measured by the failure of these spores to germinate and grow was considered an adequate process time at 250° F. The safe process time for snap beans was 10 minutes; for diced potatoes was 17 minutes, and for cream style corn, 49 minutes. These times were based on a limited number of samples and should be correlated to heat penetration data before final process recommendations could be made.

It should be noted that some spoilage occurred with the control samples. The organisms were isolated and were non-heat resistant. This indicated that these organisms entered the pouches after processing. Since pinholing and delamination were observed in these pouches, this could serve as a point of entry. Thus, these data would indicate that further work must be continued on the development of films for heat processing.

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THE HEAT PROCESSING OF FOODS IN FLEXIBLE FILMS

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V. Heat Processing of Cream Style Corn

Cream style corn was selected as an experimental test product for the flexible pouches because of its high temperature long time process requirements. Three flexible films were used for this study: 8346-1 - polyethylene terphthalate-intermediate polyethylene; 8346-2 - polyester polypropylene; and 8346-3 - polyester-foil-vinyl. (Film 8346-1 had an upper temperature limitation of 230° F., and 8346-2 and 8346-3 had limits of 250° F.)

Cream style corn was prepared under commercially acceptable conditions and filled into the flexible pouches at 180° F. The pouches were heat-sealed, with care being taken to reduce the head space as much as possible. Due to the flexible nature of the films, it is impossible to obtain a vacuum within the pouch. The samples were placed in a retort rack and loaded into a water-filled pre-heated retort for processing. In addition to the flexible pouches, cream style corn was also processed in #303 tin cans to serve as check and reference samples.

During the initial phase, cream style corn in the flexible pouches was processed as follows: Film 8346-1 was given a recommended process of 108 minutes at 230° F., and a reduced process of 81 minutes at 230° F. Films 8346-2 and 8346-3 were given recommended processes of 65 minutes at 250° F., and reduced processes of 49 minutes at 250°F. The reduced processing times were calculated from the heat penetration studies. All of the tin can check samples were processed for 65 minutes at 250° F. Following processing, half of the containers were stored in a 100° F. storage, and the other half in a 70° F. storage. At periods of 1, 2, 3, 4, 12 and 24 weeks, samples of each lot were taken from both storages and evaluated for quality retention by determining the color loss. The Agtron "F" Colorimeter was used to measure the color changes, and these data are reported in Table 1.

Film 8346-1 maintained very good physical properties after a process of 108 minutes at 230° F. The pouches were not distorted or damaged in any visible way as a result of the processing cycle. However, the color of cream style corn was poor (see Table 1). This can best be explained by the prolonged heat process. The samples processed in this film for 81 minutes at 230° F. were eliminated from the study due to under-processing.

All pouches made from Film 8346-2 and processed for 65 minutes at 250° F. exhibited varying degrees of film delamination or seal destruction. In some cases where the delamination was severe, blisters were produced that covered as much as $\frac{1}{4}$ of the pouch, and in some cases caused seal failure. This delamination condition was caused by the prolonged heating at the elevated temperatures. These time temperatures caused a weakening of the lamination and a subsequent separation of the film layers. Pouches processed at the reduced time of 49 minutes at 250° F. exhibited delamination in approximately 50 percent of the pouches. The color of the corn processed in these pouches was better than the samples in Film 8346-1, but below those in Film 8346-3. There was also a very large range in color values for these samples.

Film 8346-3 produced the most satisfactory results of the three films evaluated in this study. The physical condition was good for most of the samples, with only a few showing signs of wrinkling. These were not serious enough to cause breaks in the foil or film. The average Agtron "F" color values for the samples in these pouches were

better than the corn processed in the other two films. Further, the color of the samples processed for 49 minutes at 250° F. was better than the color values for the samples processed for 65 minutes at 250° F. in tin cans.

As would be expected, the samples processed at the reduced time and stored at the lower storage temperature, had better color values than the corresponding samples with the long process and high storage temperatures.

During the summer months, Deep Gold variety sweet corn was used as cream style corn and packaged in the 8546 films. Processes of 49 and 65 minutes at 250° F. were given. It should be noted that the control samples processed at 49 minutes in flexible films spoiled, but the inoculated samples did not. This situation could not be easily explained. Furthermore, samples processed in film (8546-2) were spoiled after one month's storage regardless of the process time at 250° F., due to breakdown of the film. All samples were stored at 70° F. for a period of 10 months.

Cream style corn from Deep Gold variety darkened in color for the first three months and then became lighter until the end of the storage period. This color reaction was obtained regardless of the packaging material. Samples processed in film 8546-3 became the lightest in color (Table 2). When compared to the samples processed the same length of time in the 8346 films the corn was not as dark in color. It should be noted that the variation in color of replicate lots was not as great for samples packaged in the 8546 films as it was in the 8346 films. This would indicate a more even heat distribution was obtained throughout the pouches.

The product was acceptable after 10 months' storage, and possessed a color similar to that of a product processed in a tin can.

Table 1 - The Average (4 Replicates) Agtron "F" Values (the higher the value the better the color) for Cream Style Corn Processed in Flexible Films and Stored at the Indicated Temperatures. The Sampling Time Indicates the Length of Time in Storage.

	Film 8346-1 230° F. for 108 min.		Film 8346-2 250° F. for 65 min.		Film 8346-3 250° F. for 65 min.	
Sampling Times	Agtron "F" 70° F.	Values 100° F.	Agtron "F" 70° F.	Values 100° F.	Agtron "F" 70° F.	Values 100° F.
1 week	58.50	55.88	54.88	51.00	58.25	55.25
2 weeks	58.50	55.38	47.00	50.33	59.50	54.33
3 weeks	54.50	52.00	48.50	50.25	56.00	55.25
4 weeks	56.13	51.63	51.25	50.13	57.83	55.38
3 months	51.75	49.25	45.63	46.50	58.50	50.25
6 months	50.63	44.83	44.25	44.50	50.50	45.50

	Tin Can "C" Enamel		Film 8346-2 250° F. for 49 min.		Film 8346-3 250° F. for 49 min.	
Sampling Times	Agtron "F" 70° F.	Values 100° F.	Agtron "F" 70° F.	Values 100° F.	Agtron "F" 70° F.	Values 100° F.
1 week	57.67	55.17	62.38	59.75	64.38	62.00
2 weeks	58.00	58.00	62.00	59.25	65.00	64.38
3 weeks	58.83	58.83	57.25	55.63	62.63	61.25
4 weeks	59.83	57.33	57.00	53.50	61.17	60.38
3 months	52.50	53.50	51.63	50.50	54.83	54.75
6 months	53.25	55.50	51.88	46.00	56.00	43.30

Table 2 - The Average Agtron "F" Values for Cream Style Corn Processed in Films 8546-1, 3 and 4 at 250° F. for 65 Minutes, after 3, 6 and 10 Months' Storage at 70° F.

Storage Period (Months)	Average Agtron "F" Values for samples processed in Film 8546		
	1	3	4
3	-	33.6	28.7
6	43.0	49.0	41.6
10	49.9	61.6	54.5

THE HEAT PROCESSING OF FOODS IN FLEXIBLE FILMS

By

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VI. Snap Beans

Snap beans were chosen as a test commodity representing a low-acid, green vegetable. In the initial phase of this study, the beans were obtained during the winter months from Joe Hatton, Inc., Pahokee, Florida. The beans were received in excellent condition, although they were not a variety that was highly recommended for processing.

During the summer months, Earligreen, Slenderwhite, and Slendergreen varieties of snap beans were grown according to accepted commercial practices on the Ohio State University Farm. The raw materials were brought to the Fruit and Vegetable Processing and Technology Pilot Plant and prepared for processing.

Procedures:

Thirteen ounces of beans plus three ounces of brine were filled in each pouch. The pouches were sealed and placed in the retort for processing. During the initial study the pouches were placed in retort baskets. In the later phases, the pouches were placed in a specially designed rack which allowed the pouches to lay flat.

Process times were varied from 9 to 10 to 12 minutes at 250° F., or equivalent processes at 240° F. and 230° F. After processing, the pouches from the initial study were stored for six months. During the latter study they were stored for ten months. U.S.D.A. grade, color, and pH were determined on the finished product.

Results and Discussion:

After six months' storage the samples processed in tin cans possessed a better color than those processed in flexible films; that is, Agtron "F" values above 60 for the former as compared to Agtron "F" values below 60 for the latter. Snap beans processed in Film 8346-3 were of a more typical canned bean color than those samples processed in the other two films. In general, a large variation in color readings were obtained due to placing the pouches in a retort basket.

Samples which were considered sterile were cooked and evaluated for flavor. The results indicated that beans processed in tin cans were preferred, followed by samples processed in Film 8346-3 and with samples in 8346-2 being rated as unacceptable.

The results for the ten months' study are presented in Table 1.

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Table 1 - Agtron "F" Values for Snap Bean Varieties Processed at 250° for 12 Minutes after 3, 6 and 10 Months' Storage at Room Temperature

Variety	Storage Period (Mo.)	Average Agtron "F" Values for Films 8546- : 1	2	3	4
Earligreen	3	63.7	-	65.0	64.3
	6	60.0	66.0	67.0	63.5
	10	70.0	63.0	66.0	61.0
Slenderwhite	3	61.0	-	61.0	65.8
	6	-	52.0	59.0	62.0
	10	62.3	60.0	50.0	51.0
Slendergreen	3	66.0	70.0	64.0	68.0
	6	-	57.0	61.0	62.0
	10	53.0	53.0	53.0	58.0

The data indicated that beans from the Slenderwhite variety seemed to be best suited for retort processing in flexible films. In the opaque films (8546-1, 2 and 3) the beans became darker during the first six months of storage and then the color returned to near the original reading after 10 months. The beans in the clear pouches (8546-4) continued to darken throughout the storage period.

Slendergreen variety snap beans darkened throughout the storage period regardless of the film in which they were packaged. On the other hand, samples of snap beans of the Earligreen variety became lighter in color when packaged in the two vinyl films (8546-1 and 2) and darkened when packaged in the polypropylene pouches (8546-3 and 4).

The general appearance of the beans was rated as fair for sloughing, and splitting of the pods was evident. This was probably due to excessive flexing of the pouches during processing. However, it should be noted that the color after ten months' storage was as good or better than the color of the beans packaged in the 8346 films after six months' storage. Color variations were also reduced. This was probably due to use of the specially constructed rack during processing, improvement in the pouch materials, and to the selecting of snap beans varieties desirable for processing.

Thus, the data indicated that variety had an important role in the processing of snap beans in flexible pouches. Secondly, an acceptable product could be obtained after ten months' storage. Further, food products in flexible films could be successfully retorted and stored, thus making this a commercially usable package.

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